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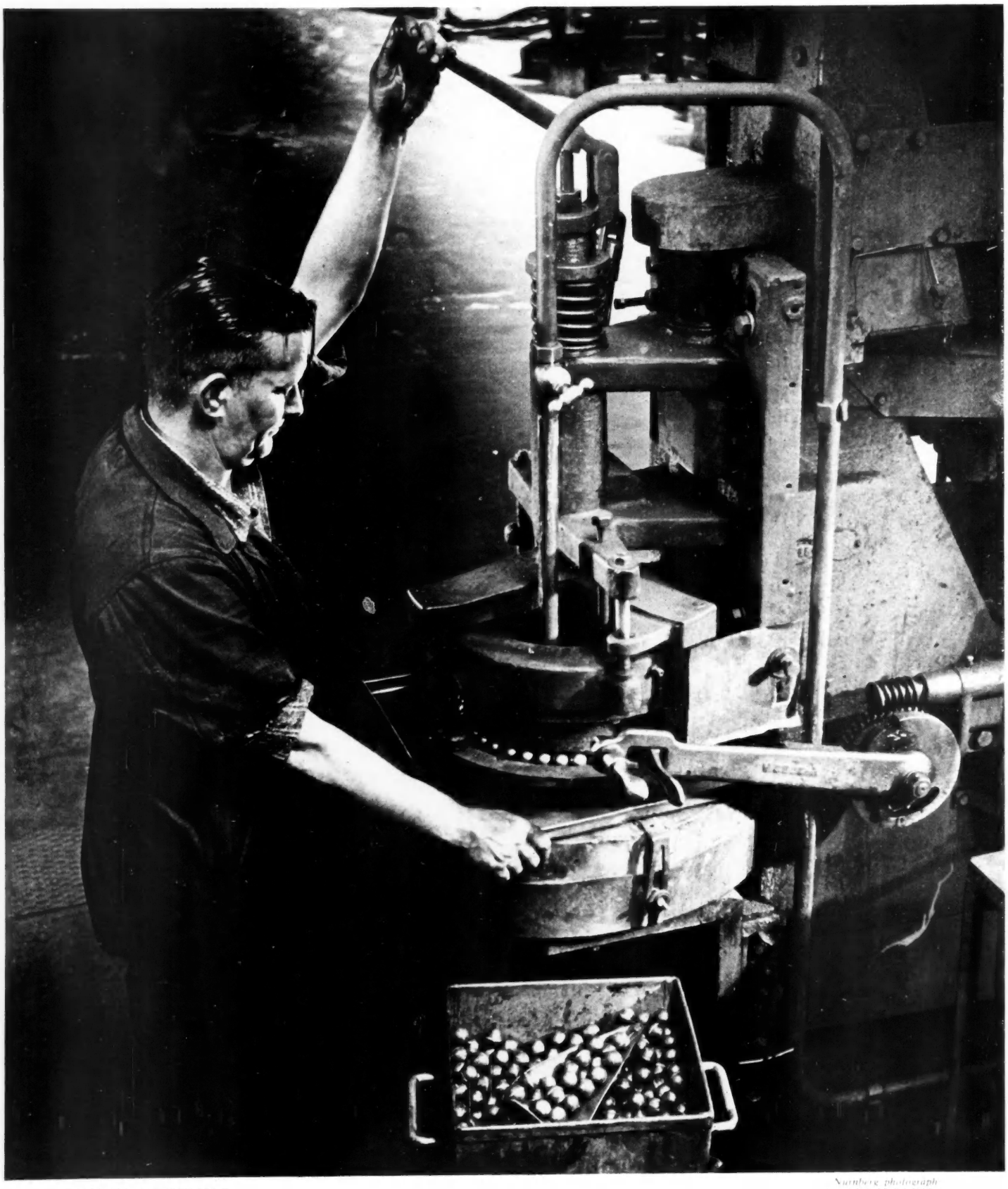

ROUGH GRINDING

Nurnberg photograph for ENGINEERING

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Vol. 184 No. 4771 AUGUST 16, 1957

Leading Article
Will Anybody Listen? 193

Plain Words 194

Weekly Survey 198

Principal Articles
Data on Human Performance for Engineering Designers 194
Towards a United Europe: A Five-Year Experiment in Coal and Steel 201
Oil and Abrasion-Resisting Rubbers in Engineering 202
Furnaces for the Aluminium Die-Casting Trade 204
Hydro-Refining Coal-Tar Products 205
Control of Level:
2—Liquids in Open Vessels and Reservoirs 206
3—Liquids in Closed Tanks and Pressure Vessels 207
Loading Counter 209
Stud Welding 209
Bursting Discs for High-Pressure Hydraulic Systems 210
Economical Bus and Coach Chassis 211
General Purpose Truck 214
Crating Bottles 214
Two Pumping Limits 214
High-Pressure Industrial Hydraulic Pump 215
Furnace Dismantling 215
Twin-Jaw Vice 215
International Institute of Welding 215
Kariba and Rhodesia's Power Needs 221

Obituary
Mr. H. H. Johnson 222

Letters to the Editor
Technical Writing as a Profession 200

Book Reviews
Worldwide Occurrence of Sporadic *E* 212
Messen und Regeln in der Chemischen Technik 212
Steelplant Refractories: Testing, Research and Development 212

Trade Publications 213

On the Shelf 213

Notes
Large Industrial User of Town Gas 205
Uses of Tin 205
Handling Cartons 205
Used Machines 211
Two-Wheel Trailer 214
Power Transformers in Southern Rhodesia 215

Marketing 216

Atomic Review
Concrete Cases 217

Notices of Meetings 220

In Parliament 223

The Human Element 224

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WILL ANYBODY LISTEN?

We have all had sufficient experience of the sad fact that though our incomes go up from time to time our purchasing power seems to go up much less. For professional people in particular, rises have had the qualities of a mirage: they have looked very attractive at first sight but they have dissolved into thin air when we have approached them. The cynical, but not altogether unrealistic, view of inflation is that it is an inevitable consequence of full employment. But if that view is not wholly accepted—if, in fact, it is possible to put the brake on inflation—there are solid grounds for hoping that the Government's new independent Council on Prices, Productivity and Incomes will generate a new public awareness of the folly of inflation. The big question now is: Will anybody listen to the reports which the Council will be issuing?

According to contemporary theories of communication the fundamental requirement in successful communication is trust. Experiments have shown that the same idea or piece of information will be accepted or spurned depending on whether it is put over by someone who is trusted or mistrusted. Trust is most likely to exist when, for example, the personal interests of the speaker or writer are known to coincide with the personal interests of the audience. Hence the ease with which a shop steward can move his workmates where the union boss from headquarters is apparently powerless. How much more difficult it is therefore for a highly placed industrialist to communicate with the men on the shop floor. And how difficult it is, too, for a politician, of the Right or the Left, to persuade the public to accept notions that are obviously logical and indisputable. It is not what is said but who it is that says it.

On that score the Government have been shrewd in appointing a council consisting of three men who are independent of politics and of the employers. Lord Cohen, chairman of the council, has served the country not only as chairman of the Royal Commission on the Taxation of Profits and Income, but also as chairman of the court of inquiry into the Comet accidents. He possesses exceptional powers of critical analysis and appraisal. His colleagues on the Council, Sir Dennis Robertson and Sir Harold Howitt, are respectively an economist and a chartered accountant of outstanding repute. What they have to say in their reports will undoubtedly be objective and constructive, and it will be respected by all who have knowledge of business and public affairs. The fact that all three have titles is simply a measure of their ability and experience, but it may be unfortunate in that they will be bracketed with Cabinet ministers and top industrialists by the mass of wage-earners in the country. This "disability" may be overcome if the council, from the start, show that their main concern is to guard the purchasing power of the wage-earner's pay packet. That is what really matters to the individual man and his family. And if, with increasing productivity, he gets a rise, he wants to enjoy the benefits and not find they are frittered away by a simultaneous increase in prices.

The council's terms of reference are: "Having regard to the desirability of full employment and increasing standards of life, based on expanding production and reasonable stability of prices, to keep under review changes in prices, productivity and the level of incomes (including wages, salaries and profits) and to report thereon from time to time." The reports will not be made to any Minister but will be made generally available to the public. They are more likely to be critical of the Government and industry than of wage-earners themselves. They may reasonably point out that in the present mixed economy of this country—part private enterprise and part Government controlled—there are too few people directly concerned and worried about the continual increases in prices and wages. Apart from those who are responsible for running private industrial firms, i.e., those who are subjected to the discipline of the balance sheet, there are few who lose any sleep over the inevitability of inflation. In nationalised industries, central Government and local government the senior officers are directly concerned, but the majority of staff and employees are not affected and are therefore not interested.

By appointing an independent council the Government may seem to be copying a technique which has achieved some recognition in industry; namely, the practice of calling in a group of experts to study the organisation of a firm or to study certain aspects of the business. There is, however, this important difference—that whereas a firm of management or marketing consultants gets down to practical, executive details and reports confidentially to the board of directors, the Cohen Council have the more difficult task of making a penetrating analysis of the whole national economy and then presenting their findings—whatever they may turn out to be—in such a way as to generate restraint at all levels. The council will have to say things which the Government themselves cannot say—or, if they did, would not be accepted by the mass of people. If they can speak not once but many times, so much the better; for only by repetition will their message make an impact. And if they can

speak with such an independent voice that they will appear to be asking for the sack, then, perhaps, enough people will listen and heed their words. If they tell us that inflation is inevitably associated with full employment then at least restraint, wherever it can be exercised, can help to keep inflation in step with increases in productivity. And if nobody listens, there is another answer—productivity must outstrip inflation. The engineering industries are the key to this solution.

* * *

Plain Words

By taking television viewers into the stately homes of Britain, the B.B.C. are doing something more than feeding the nostalgic curiosity of a people with great traditions. They are refining our taste, stimulating a desire for elegance and nobility in our surroundings.

Though poverty has virtually disappeared from the land, there is still too much drabness and squalor, especially in the industrial areas. The sitting room or parlour may be trim, but outside the houses the detergent-white washing shows up the meanness of the streets, the forlornness of the waste lands, the encircling gloom of the buildings. Some improvement may come from the operation of the new Rent Act, and from the prosperity which all classes enjoy—except those living on fixed incomes—but a real change can only come from a change in the public's scale of values. Such a change is not as remote as it sounds; in fact it is quite a possibility.

Just as there is a limit to the number of people who can achieve popular fame or notoriety at any given time (this has nothing to do with the personalities themselves but is a function of mass psychology), so there is a limit to the number of sports, pastimes or habits which can achieve the distinction of being the correct thing to do or, more crudely, be regarded as social "musts." There is no doubt which of the various mass-communication media now exerts the most formative influence. Television, even more than radio, moulds popular fashions. Just as radio widened the audience for classical music so television has, for example, awakened public interest in horse-jumping and raised the rather dry profession of archaeology to something of a cult. The popular Press is quick to follow the lead of television; so the effect is reinforced. The stately homes are already fairly high in the scale of values—sufficiently high at least to influence people's habits and tastes in interior decoration and external architecture. The B.B.C. are thus achieving what the ordinary forces of commerce and industry have failed to do—they are laying the foundations for a new generation that will be more sensitive to its surroundings than we are. To-day, no one starves; to-morrow no one will stomach ugliness.

DATA ON HUMAN PERFORMANCE FOR ENGINEERING DESIGNERS

By K. F. H. Murrell, M.A., F.R.P.S.*

When designing equipment which has to be operated or controlled by a human being it is vitally important, if maximum efficiency is to be achieved, that the limitations and capabilities, both physical and mental, of the operator should be considered in relation to the capabilities of the machine. In other words, the task should be designed as a man-machine unit.

The performance of a man-machine unit may be considered as a balance (Fig. 1). On the one side are the demands of the job, on the other side is the ability of the operator. If these are balanced the performance will be near the maximum. The ability of the operator may be improved by good equipment design and by good work environment. On the other hand, performance may be hindered by bad equipment design, poor working environment (excessive heat or humidity, insufficient light), stress, age, and anxiety. If any of these are added to the right-hand side of the balance, performance will deteriorate.

> "*If you give a man a poor tool to work with and he comes to disaster—don't blame the man, blame the designer.*" . . Sir Henry Royce.

An example of this is given by the results of an experiment in which the subjects were asked to track (follow one moving pointer with another) with a positional control or a velocity control. A positional control is a control directly linked to the following pointer; a velocity control is one that governs the speed of movement of the following pointer. It was found that learning was slower with the velocity control, but after sufficient practice the performance with both types of control was equivalent. In positional control there is an expected relationship between movement of the control and the pointer being tracked, whereas in the velocity control there is no direct relationship between the position of the pointer and control. It can therefore be said that the positional design is superior to the velocity design (this has been demonstrated in a number of experiments[1, 2]).

"Stress" was then added to the situation by making the subjects do mental arithmetic or watch for warning lights or answer verbal questions while tracking. It was then found that performance with the velocity control deteriorated substantially. This experiment illustrates, therefore, two important points, first that learning with a well-designed control which follows the expected relationship between the pointer and the control is quicker than with the less-well designed relationship, and that the well-designed relationship can counteract the effect of the added stress. Thus, to go back to our balance, should stress be added to the right-hand side, it should have been counteracted by adding good equipment to the left-hand side of the balance.

Designers already know well the capacity of the machines they design and the characteristics of the materials they use. The data given in these articles impart such information as is available about the capacities of the men and women who have to work the machines. The use of these data will aid the engineer in designing equipment so that it matches human capabilities. The data will deal with aspects of conveying information to the operator (displays), the design of controls for efficient human operation, data on the shape and size of men and women and on seating and posture. They will also give data on the effect and reduction of radiant heat stress and of noise, and on lighting. It is not intended

* Department of Psychology, University of Bristol.

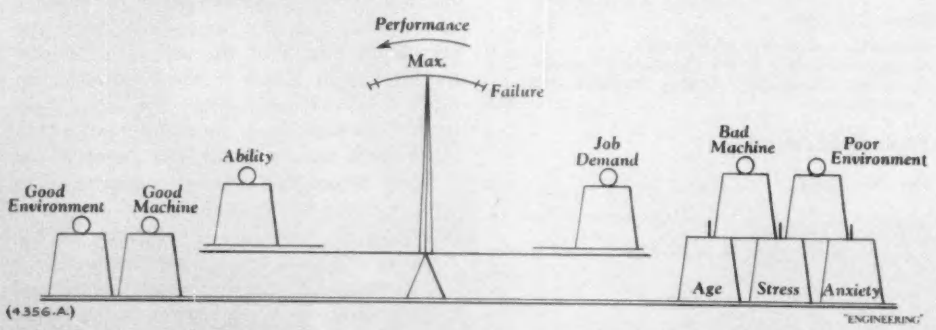

Fig. 1 (above) The performance of a man-machine unit may be considered as a balance.

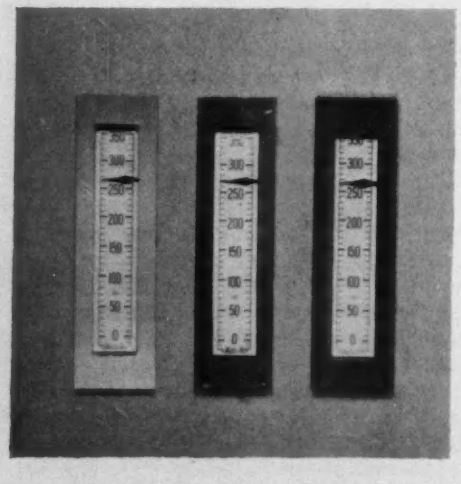

Fig. 2 Heavy black bezels or instrument cases tend to reduce the prominence of the pointer.

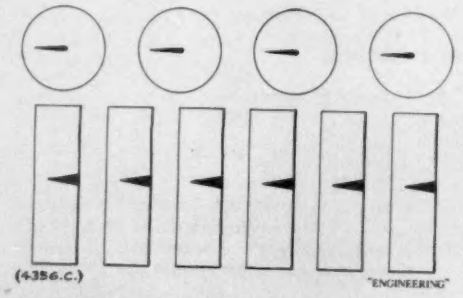

Fig. 3 Dials should be arranged so that the normal positions of the pointers form a pattern. Any deviation of a pointer from normal is then immediately noticed as a disruption of the pattern.

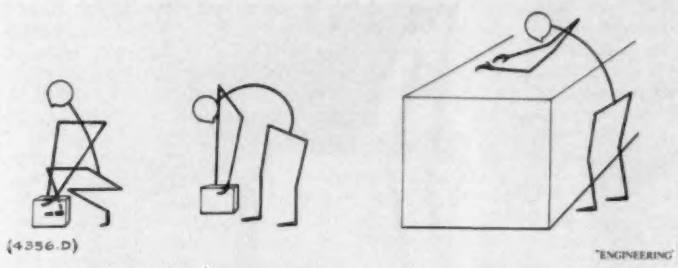

Fig. 4 Fig. 5 Fig. 6

Fig. 4 When picking up a heavy object from floor level, the operator should have his knees bent and his spine erect.

Fig. 5 If the spine is bent when picking up a heavy object, the back may be strained or the spine damaged.

Fig. 6 Heavy objects should not be lifted when the spine is partially bent and the arms extended.

to present a text-book on the subjects covered, but only to summarise the usable information with sufficient of the background information to make the data understandable. Those who want to go more deeply into a subject should study the selected references given with each section.

Caution should be used when using the data since some of the principles which are included may not yet have been established beyond all reasonable doubt, nor has it been always established that failure to implement them will lead to a serious loss of efficiency. If, however, they are followed with these limitations in mind, the designer may rest assured that his equipment is as efficient as it is possible to make it in the present state of knowledge. Where any doubt exists as to the applicability of these data it is advisable to consult an expert in the Ergonomics field.

The results of good work design do not by any means always appear as an increase in productivity which can be measured in parts per unit time. The effects may equally appear in reduction of labour turnover, absenteeism or accidents, or in prolonging the useful working life of older persons (i.e., those over 50 years of age). All these are very real gains. The fact that equipment and environment are being studied can be a very real booster of morale.[5]

DESIGNING EQUIPMENT FOR HUMAN USE

The design of equipment for human use may mean a compromise between the needs of the man and of the machine. First the following questions should be considered.

How will the machine fit the operator? Can he sit or must he stand? Will his posture be satisfactory? Is the equipment likely to be operated most of the time by a woman? What information needs to be conveyed to the operator and how can it best be given: by seeing things happen; by visual or auditory displays? If by a display, which type will give the information quickest and with the least ambiguity?

What controls are needed and what type should they be? What loads are involved and will servo assistance be required? What form of communication is required between operators? Must it be verbal and if so will noise interfere? What physical work will the operator be required to do? Is it within his physical capacity or will mechanical assistance be needed? What are the physical conditions likely to be? Will the machine be noisy? Will it emit heat? What illumination will be required? Will the physical or mental demands of the equipment be such as to overload the operator? If so what steps should be taken to reduce the load? What are the expected maintenance requirements?

Ideally, equipment should, as far as possible, be designed around the operator, and for this purpose the dimensions of men and women need to be known. These are given in the section on body measurements. Where the equipment is likely to be used exclusively by women the dimensions for females should be used.

Whenever possible the operator should have the opportunity of sitting at his work. High seats should be used because the equipment will then be correctly positioned for standing or sitting and because it is easier to make adjustable foot rests than adjustable seats and equipment. For the design of seats see the section on seating.

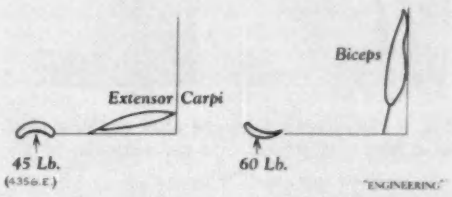

Fig. 7 With the elbow as a fulcrum, the force developed at the hand depends on whether the palm is facing up or down.

Choose each display, whether it is a single dial or one of many in a panel, so that it is best suited to its primary use, that is the use which will occupy the greatest length of time or in which speed is of greatest importance. (See section on uses of displays.) If numerical value is to be given use a counter wherever possible instead of a dial. Gibbs[6] has done this very successfully in substituting a counter for a vernier on the cross slide of a lathe and there are many other situations where the conventional dial can be replaced with advantage.

When displays and controls are used together their relative movements should be compatible. (See section on control-display relationship.)

Control panels should be designed so that there is maximum operator efficiency in the three likely phases of activity; watch-keeping, when the operator is waiting for something to happen; warning, when the operator becomes aware that something is not functioning correctly; action, when the operator takes steps to put things right.

While watch-keeping, the comfort of the operator is of primary importance. He should be well seated and it should be possible for him to walk about from time to time. Auxiliary tasks should be introduced to relieve boredom. Panels should be narrow, if possible subtending an angular width of not more than 65 deg. at the eye. The most important displays should be in the top left of centre and none should be more than 10 deg. above or 45 deg. below eye level. It appears that horizontal scanning is more likely than vertical, so important associated dials should be side by side rather than one above the other. The panel colour should be restful and warm with a reflection factor about half way between that of the dial faces and the surroundings. Dial faces should never be darker than the panel. Lighting should be restful and should not throw sharp shadows or be reflected from cover glasses or plated parts. Any lights which are normally in the field of view, such as warning lights, should be not more than three times brighter than their immediate surroundings.

For warning it is important that any deviation from normal should be evident immediately—the pointers of dials should therefore be as prominent as possible. Heavy black bezels or instrument cases tend to " kill " the pointer and markings (Fig. 2) and should not be used. Self-coloured aluminium or sandblasted brass can be used or coloured bezels, provided the colour is not intense. When pointers are patterned in relation to their " normal " readings a deviation is noticed 100 per cent. more quickly than when the " normal " positions are random (Fig. 3). The standard arrangement of 270 deg. dials is unsatisfactory in this respect since

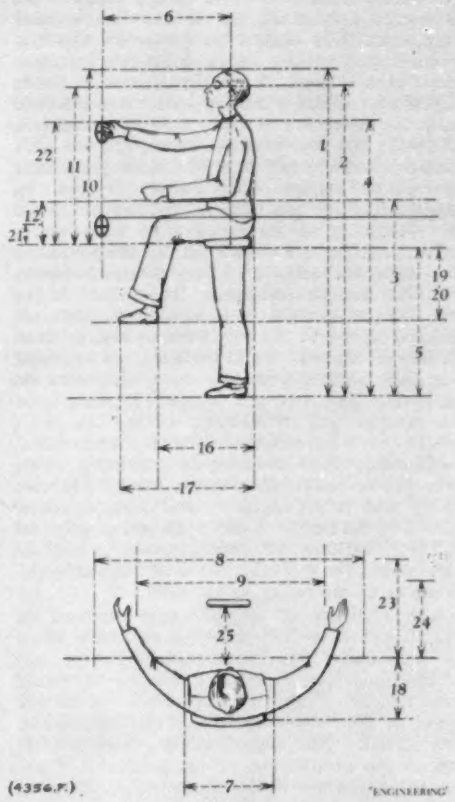

Fig. 8 The diagrams indicate the location of the dimensions specified in Table I.

patterning can be achieved only by having normal at half the maximum, which is uneconomical and usually means having to use a larger dial than is necessary. Patterning can be achieved (where normal readings remain unchanged) by choosing scale ranges so that the " normal " is, say, 2/3 maximum. Zero should then be located at one of the cardinal positions, the choice depending on the nature of the control, if any, associated with the dials (see section on control-display relationships). It does not seem to matter at which of the cardinal positions the pointers are patterned. Normal position or range of positions should be suitably marked on the dial, other marking being included only when they are needed to give additional information. Panels designed in this way are easier to learn than " random " panels.

On very wide panels it is advisable to fit warning lights above important dials which have to be located towards the extreme edges. Preferably the lights should burn dimly when all is well and start flashing when there is a deviation from normal. This guards against electrical failure.

When action is required the dial which has deviated must be identified, its meaning must be understood, the control which is to be operated must be identified and operated quickly and correctly. Identification of dials is assisted by dividing them into groups of 5 to 7 dials and by colour coding. There is some evidence that vertical edgewise dials give a clearer indication of the meaning of a deviation than do circular dials because an up movement of the pointer always means increase, but this is probably

not of such importance as the compatibility of the display and its control, and will not warrant the use of this type if there are over-riding reasons for using some other. Controls located beneath their associated displays are easily identified (they should never be above the display). If they are remote from the panel they should be grouped in the same arrangement as the dials and similarly coded.

It will have been noticed in the above that various positions of zero on circular scales have been mentioned. To avoid confusion the different situations will be summarised. The standard arrangement has nothing to recommend it except convention, for if the dial is used economically it cannot be patterned and the pointer will usually move down for increase. Zero at 6 o'clock allows the pointer to work across the top half of the dial, which is compatible with the movement of rotary controls and this is probably the best position except for use with valves, when it should be at 12 o'clock (see section on control-display relationship). It can be argued that for use with levers, and for quick understanding of the meaning of a deviation, zero should be at 3 o'clock so that the pointer is moving up for increase. In any of these positions pointers can be patterned. Thus there is no one type of circular scale which will meet all requirements and this might be an argument in favour of edgewise dials. When these are used vertically their meaning is clear, they can be patterned and they are compatible with lever movements and reasonably compatible with rotary controls (except valves). When used horizontally their meaning is reasonably clear, they can be patterned, they are compatible with levers and rotary controls and with valves if zero is at the right. Either type can be grouped together and they will probably take up slightly less space than a similar array of circular dials. Some types are easier to maintain.

The addition of diagrammatic material to panels will make it impossible to follow some of the above recommendations. Panels will have to be larger, which may increase the visual load, and either controls will have to be further apart or their association with displays will be less direct. The diagrammatic material will reduce the prominence of the pointers. These disadvantages are likely to be small, however, where control is mainly automatic and where human operation is confined to a small group of controls. The use of diagrams has much to recommend it when the process being controlled is so complex that learning would be slow and operation difficult without them. But the diagram should be unobtrusive and quiet in colour since it will no longer be needed once the operator has learned the panel.

Always design panels with the operator in mind (he has to live with them) and do not do anything which will be to his disadvantage just to produce a show piece.

To achieve the best relationship of body to controls and eye to display, the controls should usually be closer than the display to the operator. This is important when controls are used continuously, and precludes the mounting of displays and controls in the same plane. They should, however, be mounted in parallel planes with the controls nearest to the body if a useful control-display relationship is thereby achieved. When the controls are used rarely, control and display may be mounted in the same plane.

The optimum position for controls with light loads is in front of the body at elbow height. Accuracy of operation of controls falls off appreciably if they have to be operated away from this position. When some force has to be applied they should be at shoulder height. All controls should be within reach of the smallest expected operator. Reciprocating controls should move in a direction to and from the body of the operator, and shafts of rotary controls should normally be in line with the body. Controls operated in sequence should be near to each other, with the most important and most frequently used in the centre. Controls which have to be operated in rapid sequence should

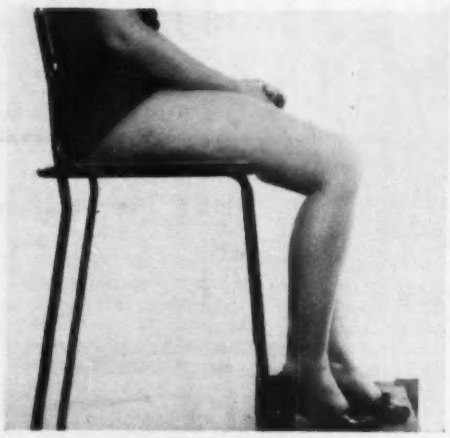

Fig. 9 Discomfort is caused when the front edge of a high seat presses into the underside of the thigh.

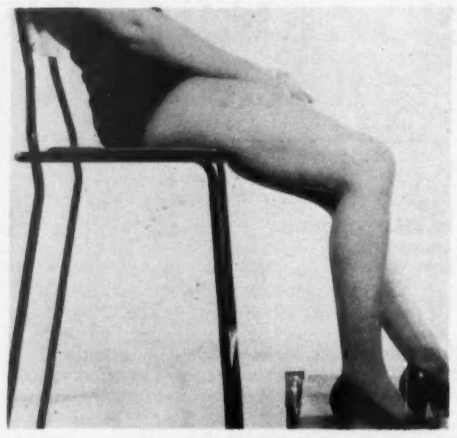

Fig. 10 Often, to alleviate pressure on the thighs, the buttocks are slid forward on the seat, producing an unsatisfactory posture.

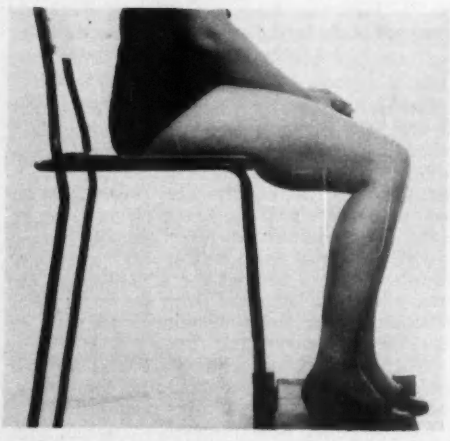

Fig. 11 Another method of alleviating pressure on the thighs is for the sitter to sit on the edge of the seat, but this posture loses the use of the back-rest.

Fig. 12 It is important that the seat should be of a height rather less than the distance from the underside of the knee to the heel, due allowance being made for the curve of the thigh.

Fig. 13 A flat seat of polished wood will provide insufficient friction to prevent the buttocks from sliding forwards when the back-rest is used.

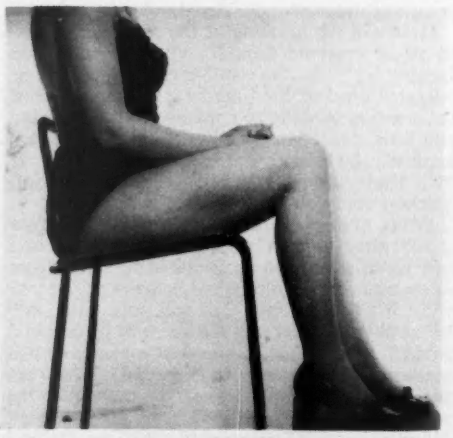

Fig. 14 To counteract slipping, the seat should be at an angle of 5 deg.

be incorporated into a joystick so that the hand does not have to be moved from one control to another. Controls should be coded for identification by feel rather than by colour and where controls have to be identified with dials or similar displays it is desirable that they should be grouped in the same pattern as the dials. Where a large number of controls and dials are involved they should be split up into groups of 5 to 7, since it is easier to identify immediately one particular dial and control in a group of these numbers. Controls which are to be distinguished by touch should be about 6 in. apart. All detachable equipment should have fixed places to which it can be returned without fumbling and preferably without visual aid. Two-handed movements should be used whenever possible, with controls, etc., distributed between both hands. Two-handed movements should be symmetrical. Most frequently-used controls should be grouped in most accessible places. Hand movements in the horizontal plane are smoother, less tiring and more accurate than movements in the vertical plane. So also are movements outward from the middle of the body. Avoid mounting control levers on crank handles.

Positional control, i.e., a control which is

linked directly with the movement of its associated equipment is easier to learn and less likely to cause accidents than a velocity control which controls the speed of movement of a part of the equipment, even when the control and the machine move in the same sense.

Where more than one operator is involved, verbal communication can be used provided the noise level is not too high. Telephonic communication by means of hand sets interferes with the operation of controls. Loud speakers may be a useful alternative provided they will not distract other operators unduly. In other circumstances possibilities of communication by indicator should be explored.

Arrange equipment so that the operator can work with a good posture. Avoid making it necessary to lift weights in awkward positions, for instance at arms' length; parts should be slid into position rather than lifted. Provide mechanical assistance where weights approach the limit for manual lifting or are awkward to grasp. (See section on body structure.) Avoid designs which produce unnecessary high noise levels, particularly in the higher frequencies. Consider alternative methods which are less noisy. (See section on noise.)

Screen operators from radiant heat, not forgetting solar heat, as in outdoor crane cabs, or secondary heat emitters such as cooling forgings. Any surface with a temperature above 200 deg. F. will probably require screening. (See section on industrial heat.)

Ensure that there is sufficient light for the requirements of the task, not forgetting that both operators and overhanging machines will cast shadows. Consider the lighting requirements for maintenance. Provide for non-glaring supplementary lighting when necessary. (See section on lighting.)

Plan equipment so that it can be easily maintained. Avoid situations which make extensive dismantling necessary in order to make minor adjustments, especially if they are likely to be frequent. Ensure that parts which are likely to require regular inspection are accessible, and don't expect the fitter to be a contortionist.

Finally, when circumstances permit, make a mock-up and give the first-off a thorough user-trial. Put yourself in the place of the operator and the maintenance man and try to do everything yourself which you would expect them to do. Use imagination to decide what the user will find difficult or irritating and put it right. Attention to all the matters outlined above may seem trivial, but it is far better to design equipment correctly from the start than to have to make inefficient modifications later or have the equipment working below capacity.

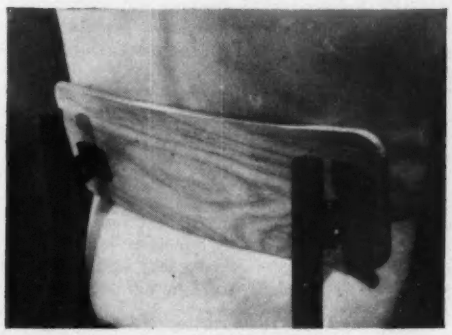

Fig. 15 Back-rests should pivot to allow for adjustment to the backs of individual chair-sitters.

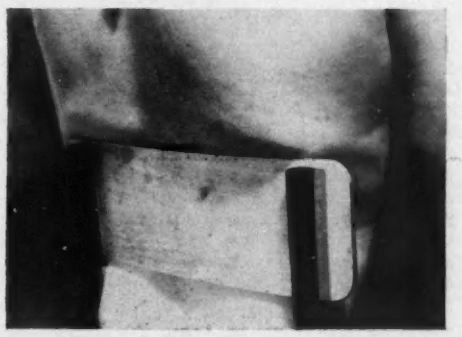

Fig. 16 A fixed back-rest will cut into the back of the sitter.

BODY STRUCTURE AND MOVEMENT

The skeleton consists essentially of a series of levers (the limbs), joined by an articulated column (the spine), operated by a muscular engine. The limbs are designed for the application of force, whereas the spine is not; it is intended to be used in an almost vertical position and is relatively inefficient when flexed. Thus when picking up a heavy object from floor level the knees should be bent and the spine kept erect (Fig. 4), the work of lifting being done by the legs. If the spine is bent and the knees are kept straight (Fig. 5) strained back or even spinal damage may result. Lifting with the spine partially bent and the arms extended (Fig. 6), as for instance from the back to the front of a machine is also bad. Equipment should be designed so that the operator's posture is upright, and he should not be required to bend in order to lift or in order to see what he is doing. The limits of weight which should be lifted without mechanical aid are:

Adults

Men.	120 lb. occasionally.
	100 lb. continuously.
Women.	60 lb. occasionally.
	45 lb. continuously.

Young Persons

Male.	60 lb. occasionally.
	45 lb. continuously.
Female.	56 lb. occasionally.
	40 lb. continuously.

These are maxima and should only be called for if it is unavoidable, normally not more than 2/3 these maxima should be used.

Physical strength is greatest at about 25 years of age and may decrease by as much as 50 per cent. by age 50.

Used properly the limbs are efficient and powerful. The greatest force can be applied when an operator is seated and the arm or leg is straightened from about 165 deg., but repeated application of forces greater than 60 lb. by the foot or 30 lb. by the hand is fatiguing. When applying force with the hand in line with the lower arm, the direction of the force being perpendicular to the hand, the elbow should be used as a fulcrum, the force which can be developed depending on whether the hand is held palm up or down (Fig. 7). If the arm is straight at the elbow the shoulder becomes the fulcrum; and the whole lever system is very inefficient, and no appreciable force can be applied along a line at right angles to the arm.

The legs are primarily designed to exert force along their length. Like the arm, the leg flexed at the knee can act as a lever (the range of forces which can be applied at various degrees of flexion are given in the section on pedals) but little force can be applied at right angles to the leg with the knee straight.

Muscle burns oxygen in doing work. If a contraction is continued for a period of time the blood flow to the tissue is restricted and the muscle runs out of fuel. This results in pain and fatigue as, for example, when holding the arm above the head. Work should be designed so that continuous exertion of muscular force is avoided.

Control movements should be well within the limits of movements of the joints. The most important of these, excluding twisting, are:

The wrist (palm down)—65 deg. up; 75 deg. down; 40 deg. outward; 45 deg. inward.
The wrist (palm inward)—90 deg. forward; 60 deg. back.
The elbow (upper arm vertical)—90 deg. inward; 140 deg. up-down.
The shoulder (arm straight)—40 deg. backward; 90 deg. forward.
The hip (leg straight)—50 deg. backward; 130 deg. forward.
The knee—160 deg. from leg-straight position.
The knee (most comfortable position)—30 deg. to 120 deg. from leg-straight position.
The ankle—75 deg. to 130 deg. downward from the lower leg.

Particular attention should be paid to the avoidance of situations where the hands or feet are required to do work at or near the limits. For instance working with the wrist bent inward at 90 deg. to get behind some obstruction can cause inflammation of the tendon sheaths, and pedals which force the ankle upward to its maximum can cause pain and possibly muscular damage.

In relating control movements and machine function it should be remembered that reaction to a stimulus is not instantaneous, but takes a time of approximately 0·3 to 0·4 second for a simple response. If a choice is involved the reaction time is increased. Additionally, time must be allowed for the limb to move from one control to another, typically about 0·5 second for a 12 in. movement. The relationship between distance and movement time is approximately logarithmic. Horizontal movements of the hand are faster than up-down movements.

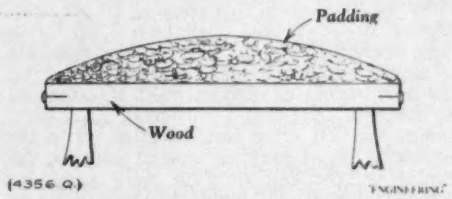

Fig. 17 The effect of padding a flat seat is to achieve a convex surface, which is undesirable.

BODY MEASUREMENTS

The dimensions given in Table I are averages which apply to subjects wearing shoes. They can form a basis for design but in many instances upper and lower limits are more important than averages. Thus in situations involving reach, for instance, the smallest should be catered for, while clearances should allow for the largest.

SEATING

The elements of good seating are (*a*) height, (*b*) the length, width and slope of the seat, (*c*) the back rest. These will be considered primarily as they effect factory and office seats.

Seat Height.—The ischial tuberosities of the pelvis are the parts of the body intended for

TABLE I.—*Body Dimensions for the Design of Equipment* (See Fig. 8)

	Male, in.	Female, in.	Range of adjustment, in.
1. Height	69	65	—
2. Eye level	65	61	5
3. Elbow height	42	40	3
4. Maximum height of controls (shoulder height)	56	52	—
5. Minimum height of controls (symphysis height)	35	33	—
6. Maximum distance of controls from centre line of body	18	14	—
7. Body width	19	17	—
8. Maximum span at working level	60	52	—
9. Normal span at working level	48	43	—
10. Sitting height above seat	36	34	—
11. Sitting eye-level above seat	32	30	4
12. Elbow height above seat	9	9	—
13. Seat length	16	15	—
14. Seat width	14—20		—
15. Depth of seat below work surface	7—9		—
16. Buttock to knee	24	22	—
17. Minimum leg room (back of seat to tip of toe)	34	32	—
18. Back of seat to front edge of bench	12—15		—
19. Seat height	17	15	4
20. When operator is seated at high bench, depth of foot-rest below seat	17	15	4
21. Minimum height of controls above seat	1	1	—
22. Maximum height of controls above seat	23	21	—
23. Maximum forward reach from front edge of bench	20	17	—
24. Normal forward reach from front edge of bench	13	11	—
25. Minimum distance of displays from eye	18	18	—
26. Maximum elevation of toe above horizontal	4½	4	Pivoted on heel
27. Normal elevation of toe above horizontal	3	3	
28. Normal depression of toe below horizontal	4½	4	
29. Maximum depression of toe below horizontal	6	5½	
30. Foot length	10½	9½	—

sitting. The tissue of the buttocks in their vicinity will withstand pressure without discomfort due to restriction of the blood flow. The tissue of the underside of the thighs is not so designed; thus, sitting upon too high a seat will cause discomfort due to pressure at the front edge of the seat (Fig. 9). This is often reduced either by sliding the buttocks forward on the seat (Fig. 10), which produces an unsatisfactory posture, or by sitting on the front edge of the seat, which deprives the sitter of the use of the back-rest. (Fig. 11.)

It is therefore important that the seat should be of a height rather less than the distance from the underside of the knee to the heel, due allowance being made for the curve of the thigh (as seen in Fig. 12) and the heel of the shoe—2 in. for the former and 1 in. for the latter. It is normal for the legs to be stretched forward or tucked under the chair. These figures make allowance for this also.

Ideally, seats should be adjustable to the individual but to obtain the maximum benefit the height of the work surface should be adjustable also. If this is not so, it is usual to adjust the seat to give the best working height in relation to the task rather than the best sitting height. People are inclined to adjust seats to the height to which they are accustomed, which is usually too high because they have rarely had an opportunity of using a seat of the correct height. For a non-adjustable seat the height should be 17 in. for a man or 15 in. for a woman.

It is more comfortable to sit on a seat which is too low than one that is too high, provided the work surface is the correct height above the seat.

For high seats, footrests should be provided: 17 in. below the seat for men, 15 in. for women. A flat surface is better than a bar since it allows the legs to be moved. Where possible, adjustable footrests should be used; this allows the relationship of seat and work surface to remain constant and non-adjustable.

Seat Length, Width and Slope.—The length of the seat should be 12 to 14 in. and width not less than 13 in., for seats where reasonable leg room is available. Too long a seat will cut the back of the legs of small people and too narrow a seat will be uncomfortable for people with wide pelvises.

A flat seat (Fig. 12), especially when it is made of polished wood or other slippery material, will provide insufficient friction to prevent the buttocks from sliding forward when the back-rest is used (Fig. 13). With such a seat, therefore, the back-rest cannot be used with comfort. The seat should slope back at an angle of 5 deg. to counteract this effect (Fig. 14). The front edge of the seat should be slightly rounded. Seats should not be shaped to fit the buttocks because this forces the sitter to remain in one position.

Back-rest.—Back-rests may be of two main types: (*a*) giving continuous support to the whole of the back, (*b*) giving support in the small of the back. The former are somewhat less practicable for industrial use and those interested in their design should refer to Åkerblom.[16, 17]

Owing to the wide variability in the shape and position of the small of the back, narrow backrests should be adjustable for height where possible. They should pivot horizontally to allow them to adjust themselves to individual differences (Fig. 15). Fixed back-rests will cut into the backs of all those whom they do not fit perfectly (Fig. 16).

The back-rest should have a shallow curve and be about 11 in. long and 4 in. deep.

Padding.—Where padding is provided, this should be allowed for when designing the seat frame. The dimensions given above should be realised when the padding is under compression. Seat pads should be level or concave—never convex, an uncomfortable result of adding padding to an already flat seat (Fig. 17).

Seating when Leg Room is Restricted.—When restricted leg room is unavoidable, the seat height should be increased and the seat width reduced so that the operator sits on the buttocks with the thighs sloping downward. Suggested dimensions are given in Table II.

To be continued

TABLE II.—*Seat Dimensions in Cases of Restricted Leg Room*

	Male	Female
When leg room is 30 in.:		
Seat height	18 in.	16 in.
Seat length	13 in.	12 in.
When leg room is 23 in.:		
Seat height	20 in.	18 in.
Seat length	11 in.	10 in.

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RURAL ELECTRIFICATION IN NORTHERN IRELAND

Although not keeping pace with similar developments in this country, rural electrification in Northern Ireland now appears to be making satisfactory progress. According to the latest report of the Electricity Board, while five years ago farms were only responsible for about 4 per cent. of the total electricity consumed, in 1956 the proportion had risen to 10 per cent. During the same year more than 2,500 farms were connected and the number now receiving a supply exceeds 15,000. During 1956, too, the Board approved schemes which are estimated to bring an additional 1,992 farms, 2,827 rural homes and 231 other rural premises on to the network. As regards the general position, the Board at the end of 1956 were supplying 152,882 consumers of whom 83,722 were urban and 69,169 were rural, while the total consumption was 465,441 MWh.

Weekly Survey

Cover Picture. *The use of ball bearings has now spread to almost every industry; and they are being made in exceptionally large and small sizes to meet many widely differing needs. Our illustration shows the balls undergoing the treatment of rough grinding.*

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Co-ordinating the Free Trade Area

With the appointment of Mr. Reginald Maudling, the Postmaster General, to supervise and co-ordinate this country's negotiations for the Free Trade Area, a new phase opens in the diplomatic exchanges which are likely to intensify this autumn on intra-European trade. To the rest of western Europe, the appointment should at least indicate that this country means business so far as the Free Trade Area negotiations are concerned. The need for a strong lead from this country has grown over the summer. There are reports that opinion is hardening on the Continent against this country's insistence that agriculture must be kept out of the F.T.A. and the French are less likely than ever this autumn to view the F.T.A. with enthusiasm since their hands are full with their own internal economic problems. It will require all the skill which the British can muster in international committees (and their reputation is high in these matters at O.E.E.C.) to steer this project through the diplomatic whirlpools which lie ahead.

There is as yet no unanimity of opinion in this country as to which industries are likely to gain and which are likely to suffer if the Free Trade Area is realised. Something like a crude highest common factor is beginning to emerge, however. It is generally agreed that, excluding industries which already have an international basis such as shipbuilding, aircraft and petroleum, the industries most likely to gain are chemicals, wool textiles, atomic energy, branches of electrical and electronic engineering, heavy engineering and sections of the metal forming and iron and steel industries. Those likely to suffer are cotton textiles, certain branches of scientific instruments, paper, watches and certain branches of light engineering. It would be dangerous, however, if labels of this kind became attached to individual companies and their prospects assessed in such correspondingly crude terms. Many companies will do better or worse than the typical concern in their own industry and some organisations are much too big and complex to be classified into any one industry at all. If generalisations on this subject are of any value the best one so far is probably that enterprising concerns with reasonable resources have little to fear and much to gain from exposure to Continental competition.

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Surveying Arid Regions

A publication by UNESCO has brought together a collection of papers written in fairly non-technical terms on many different aspects of surveying the world's arid regions (*Guide Book to Research Data for Arid Zone Development*, H.M.S.O., 25*s.*). The book points out that only one-tenth of the world's exposed land surface is cultivated and that about a quarter of the earth's surface gets less than 10 inches of rain a year. Some experts think that desert conditions are spreading naturally rather than as a consequence of over-cultivation of the land and there are difficult problems to solve in raising the productivity of marginally desert areas. The publication concerned is in two parts, the first dealing with physical and biological factors and the second with human factors.

For a long time thinking about raising the

standard of living in backward areas has been bedevilled by various sweeping assumptions. Even some of the cruder ones, such as the illusion that tropical soil which supports " bush " and jungle growth is inevitably fertile, die hard. It would appear from this book that a good deal of research is still necessary on some of the more sophisticated assumptions, such as the impression that intensive cultivation beyond a certain point creates desert conditions. In all this there is the danger that the specialists will work in water-tight compartments and the advantage of a book of this kind is that it brings together varying technical points of view on this vast subject and enables the problem to be seen as a whole, underlying a real need for co-ordinated and coherent planning in all branches of surveying, botany, biology and soil chemistry to ensure that the experts are all marching approximately in the same direction.

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Plenty of Coal

With coal stocks at about 26 million tons compared with 20 million tons at the beginning of the second half of 1956, there is clearly plenty of coal in hand to face the winter. The failure of industrial output to expand through the winter, the mild weather over the winter months and the improved performance by the coal industry until the last few weeks all combined to produce a build up in supplies rather larger than the seasonal average of recent years. The lag in output which has developed in the summer will have to grow into a marked downward trend before it is likely to affect seriously the prospects for coal supplies in the coming winter. Nevertheless the recent decline in effort at the coal face is disappointing in view of the accelerating rate of capital investment in the industry.

The price increases announced to take effect from July 1 were made in the knowledge that a surplus of £8·8 million had been earned in the first quarter of the year. The N.C.B. does not expect more than a modest surplus for the whole of 1957 which will go towards reducing the accumulated deficit of £23·8 million. The Board also intimate that their expenditure will increase in the remainder of 1957 and it is probable that both wages and raw material costs will play an important part in forcing up the cost of coal extraction. Thus, while capital investment continues at a high rate and costs of production are continually rising, output from the mines has once again encountered a setback despite the N.C.B.'s willingness to meet the miners by abolishing the bonus shift.

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Coal by Pipeline

The progress of a scheme for transporting coal by pipeline in Ohio, United States, suggests that this may become an important competitor to rail transport. So far the project has been experimental but the results of the experiment are encouraging. The " test shipment " of some 200 tons of pulverised coal was made along a pipeline running from the coal mines of Pittsburgh Consolidation Coal Company in Hanna near Cadiz to the Cleveland Electric Illuminating Company's Eastlake plant on Lake Erie, a distance of 108 miles.

The pipeline's capacity, carrying finely ground bituminous coal mixed with water is expected to be 3,700 tons a day or 1·3 million tons a year. The estimated saving in transport costs over rail freight charges is at least 50 per cent.

The National Coal Board have for some time been experimenting with hydraulic transport of coal, though not on the same scale. Large rather than pulverised coal has been handled, and difficulties have been experienced except where the lumps are of a fairly even size. If the Ohio project proves commercially successful in operation it is likely to influence research in the transport of pulverised coal from pit head to power station. So far British engineers have concentrated on attempting hydraulic transport direct from the coal face.

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Coal and Steel Anniversary

Last week-end the first large-scale experiment in establishing a common market in Europe was five years old. The High Authority of the European Coal and Steel Community, set up on August 19, 1952, by a handful of enthusiasts, has achieved much more than had been hoped even by the most enthusiastic of its promoters. How it succeeded in abolishing trade barriers and transport anomalies and how it influenced the growth and organisation of the coal and steel industries concerned was described in an article we published last week. The High Authority's influence on technical research, and the assistance it gives to projects likely to assist in solving the Community's raw materials problem, are examined in an article published in this issue.

The High Authority is faced by a " growing gap between supply and the demand for energy." The main coal producers of the Community recently decided to co-ordinate their future action on fuel economy. The first step will be " to summarise the progress each of them has so far made individually in investigations into the national utilisation of coal," compare notes and agree on a programme. In view of the efforts already made to ensure efficient coal utilisation, the producers will concentrate on " miscellaneous industries " and " domestic consumption."

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Zinc Smelting Process

The zinc smelting process developed by the Imperial Smelting Corporation and described recently in a paper read by Mr. S. W. K. Morgan, Research Director of the National Smelting Company, represents the first major advance in zinc smelting technique since the introduction of the electro-thermic process by the St. Joseph Lead Company in 1931. Development work on the new process began some 25 years ago but was delayed by the war: it is now stated, however, that the two pilot production furnaces at Avonmouth have produced over 70,000 tons of zinc and the process is to be installed at Cockle Creek, Australia, by the Sulphide Corporation.

In this process, zinc is produced in a blast furnace which was previously ruled out owing to its high volatility and the difficulty of separating the zinc vapour from a large volume of combustion gases. This has now been successfully achieved by using a condenser in which liquid lead is circulated for heat transfer and collection of zinc with minimum oxidation of the zinc vapour. As compared with the smelting of zinc in relatively small retorts heated from the outside, the blast furnace technique results in a considerable reduction in capital cost for a given capacity and substantial savings in fuel.

While the process is suitable for smelting high-grade zinc concentrates it is also claimed to be applicable to lower grades of ore with only a moderate increase in coke requirements per unit of zinc. In particular it can utilise materials with high iron content which are not suitable for retort or electrolytic processes. It can also be applied to mixed lead-zinc concentrates the lead being recovered as bullion, in contrast to the retort processes in which any lead present is recovered as a lead-rich material requiring separate treatment. Silver, antimony and copper can be conveniently recovered with the lead. Volatile impurities may be more troublesome and arsenic, for example, may have to be removed from the zinc by treatment with metallic sodium.

In the absence of more detailed information regarding the economics of the process than is at present available it is not possible to predict the probable long-term effect on the zinc industry as a whole. One effect should be to open up a number of deposits which are at present uneconmic to exploit. At present, partly owing to the high metal content of zinc-blended concentrates a fair proportion of smelting capacity is remote from the mines: if in fact the additional cost of smelting lower grade ores and concentrates is relatively moderate there may be a tendency to produce more metal at the mine, though availability of coke and proximity to markets for sulphuric acid will continue to favour smelters established in industrialised countries.

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Making Natural Gas Serve

The spectacular development of Canada's natural gas industry of the early 1950's, when new reserves were constantly being discovered, has been replaced by the careful planning of a comprehensive system of distribution. According to *A Survey of the Natural Gas Industry in Canada During* 1956, published by the Minerals Resources Division of the Canadian Department of Mines, last year saw the launching of construction work " in a cross-country pipeline transmission and distribution system."

The development of transport facilities has only begun " technically "—much research remains to be done and it may prove possible in the not too distant future to ship natural gas as conveniently as it is now possible to ship petroleum products. Meanwhile the considerable natural gas resources of Canada " give promise for the future of far-reaching effects in the Canadian economy." Estimated reserves at the end of 1956 exceeded 23,000 million cub. ft., or five times more than in 1950. Production has risen two-fold in the same period, mainly in Alberta which in 1956 accounted for over 86 per cent. of marketed production.

Further expansion of output is almost entirely dependent on the development of transportation. Production started last year in British Columbia and a rapid growth is anticipated starting next year, " with the first full year of operation of a gas transportation system being built to give Peace River gas fields access to Pacific Coast markets." The needs of the industry to-day are for adequate market outlets and for pipelines to reach them.

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Canada's Petroleum

The energy and drive of industrial development in Canada is well illustrated by the pattern of development of its oil industry. In 1956 output expanded by 30 per cent. compared with increases of 14½ per cent. in Latin America, 6 per cent. in the Middle East and 5 per cent. in the United States. Canada now ranks eighth among oil-producing countries and there are good prospects of further gains. The summary of developments given in *A Survey of the Petroleum Industry in Canada During* 1956 indicates that oil-field production potential was " greatly in excess of actual production and bigger market outlets for Canadian crude oil continued to be an important objective of the industry." Nonetheless, a growth from an output of 19,000 bbl. a day in 1947 with reserves at the 72 million bbl. mark, to nearly 470,000 bbl. a day with reserves at 3,129 million bbl. is no mean feat. Canada is now 65 per cent. self-sufficient in petroleum products (compared with 10 per cent. 10 years ago) in spite of a three-fold increase in domestic demand, and there are good prospects that this proportion will increase. The concentration of refining capacity in Montreal (one-third of the country's total) has yet to come within the orbit of Western Canada oil supply and is fed with imported crudes. The projected extension of the interprovincial pipeline to Toronto, however, will radically alter the position.

Discoveries of new oil reserves continue at an increasing pace. Oil, and to a lesser extent natural gas, are the mainspring of Canadian expansion and pressures are rising fast.

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Oil Refinery Expansion

The big increase in oil consumption in this country over the next few years is expected to be in the medium to heavy distillates, especially Diesel oil and fuel oil. There is also expected to be a large increase in the demand for petroleum-based chemicals. These anticipations are reflected in the oil-refinery building programme over the next few years.

Refinery capacity in this country is about 30·5 million tons a year at the moment. To judge from published information this capacity will be increased to 40·8 million tons before the end of 1959. Much of this increase will be accounted for in the large extensions at Fawley, the new Isle of Grain refinery belonging to British Petroleum Limited, which are nearing completion and Shell's expansion programmes at Shellhaven and Stanlow. By about the end of 1961 total capacity is expected to have increased to 48·3 million tons and here again it will be extensions at Shellhaven, Stanlow, Isle of Grain and Fawley which are likely to play a major part in the increase. In addition Esso will go ahead with their new refinery at Milford Haven if planning permission is granted and this will be the largest new installation included within the possible figure of 48·3 million tons.

The expansion in the production of petroleum-based chemicals will play an important part in these plans. Monsanto Chemicals Limited and the International Synthetic Rubber Company, Limited, are both expected to complete their new plant near Fawley in the middle of 1958 and Fisons Limited are building a new installation near the new ammonia plant being built at Shellhaven to produce materials for fertilisers. Increases in petroleum chemicals capacity have also been announced by British Petroleum for Grangemouth in Scotland. The result of these plans (and there are still others which may be announced before very long) means an increase of about one-third in refining capacity in the next two years and an increase of over a half in the next four years. The demand for petroleum equipment of all kinds, from pipes and storage tanks to complicated control instruments, is likely to be buoyant in consequence for some time to come.

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Office Machinery Excels

A considerable increase has taken place in the exports of office machinery during the first six months of this year, by £1·97 million to £9·78 million. This is the biggest gain secured since the industry launched its export drive in 1951 and compares with gains of less than £1 million in the corresponding period of 1956.

The growth of this industry is unrivalled by any other section of the machinery-building industry, and the vigour with which its overseas sales have been promoted is, to say the least, unusual. The United States is now the second most important market, taking £840,000 in the first half of the year. Australia is first with £1·5 million and Canada third with £818,000. The major contributors to this impressive performance were accounting machines, with £2·6 million out of £9·7 million, followed by typewriters (£2·2 million) and duplicators (£1·0 million).

The industry is now entering a period of intense competition, particularly in western European markets, but also one in which demand is expanding fast. Export consciousness will play an important part in determining further progress, but any developments towards freer trade in western Europe should assist the industry in expanding exports further. Technically, it has the advantage of a live and enterprising electronics industry. Most of the leading electrical machinery companies are taking part in the development of computers and there is little doubt that those who stay the race will be the equal of any in the world. It is encouraging that International Business Machines, by far the leading makers of computers in the United States, do not enjoy the same position of dominance in this country although they are doubtless formidable competitors. The industry's prospects, both at home and overseas, appear to be as good as any and better than most other sections of British engineering.

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Finding the Cash

The difficulties of keeping an expanding company solvent are well enough known. Despite a general increase in gross profits, moderate though it has been, earnings for equity capital are in fact lower. The explanation lies partly in increased taxation, but mainly in higher depreciation. The 1,893 companies which are included in the recent *Financial Times* analysis of the results of public companies increased the amount set aside for depreciation from £201 million to £229 million and paid out £505 million in tax, £6½ million more than the previous year.

Interesting comments on the difficulties of raising the cash needed to sustain expansion, particularly that of small and medium-sized firms, were made by Lord Piercy, chairman of the Industrial and Commercial Finance Corporation, in his annual statement last month. He pointed out that this type of company had been worse hit by the credit squeeze, "principally in respect of their capital requirements." The difficulty has not only been that the consent of the Capital Issues Committee is more difficult to obtain for small concerns, but that "access to the market is imperfect or lacking" and that there is "a lack of available sources." Therefore companies endeavour to plough back as much as they dare to sustain their efforts to expand. They have, in the present circumstances, few alternatives if they are to remain in the main stream of progress.

The functions of the public finance corporations such as I.C.F.C. and the Finance Corporation for Industry were discussed by Lord Bruce in his last speech as chairman of F.C.I. In his view the creation of the Corporation was "an act of broad vision and wise statesmanship" based on a realisation that industrial expansion and the creation of new industries required funds —"on a scale and of a character for which the machinery existing in the City was thought to be inadequate." Both the F.C.I. (for large companies) and the I.C.F.C. have provided loans, very selectively, for the companies whose activities would, in their view, benefit the national economy. They were, in the main, cases where the cover or profit record was inadequate or the venture unproved. The Steel Company of Wales, F. Perkins, Petrochemicals, Edwards High Vacuum, are examples of such companies. There are many others, however, which do not fall in this category and yet whose activities in the export field benefit the economy. For them profits are often the only source of finance.

Letters to the Editor

TECHNICAL WRITING AS A PROFESSION

From Major-General Sir E. Bertram Rowcroft, K.B.E., M.I.Mech.E., M.I.E.E.

SIR, I venture to address you on the subject of the article by Miss I. M. Slade and Mr. B. C. Brookes on the adverse effect on management of bad technical writing (ENGINEERING, August 2, page 137).

That interest in technical authorship has been aroused is indicated not only by this able article but also by the fact that during the past eighteen months two independent committees of interested parties have been giving the matter close study. The "survivor" of these is the Exploratory Committee on Technical Authorship established by the City and Guilds of London Institute to consider the need for, and the practicability of, courses of training and examinations in technical authorship. This Exploratory Committee has a wide membership, embracing not only you, Sir (representing the Institution of Mechanical Engineers), together with a number of representatives of engineering manufacturers' associations, but also the Institution of Electrical Engineers, the Ministry of Education, the Ministry of Supply, the Admiralty, the Royal Society of Arts and representatives of several associations connected with technical education and the arts.

While agreeing generally with your contributors on the scope and purpose of technical writing, the Committee have been more impressed with the urgent need for clear, concise manuals, instructions and parts lists than with the need for the technical guidance of managements. This is, perhaps, due to the status of most of the members, who represent either producers or users of engineering equipment. But it is clear that any improvement of the technical author's training and status calculated to meet the manufacturers' and users' needs could be made to cover the whole field mentioned in your journal.

Miss Slade and Mr. Brookes will be interested to know that my Committee are in full agreement with their ideas on the achievement of a high standard of technical authorship, on the scope and purpose of such authorship, and on the very real need for recognition of the profession, which carries with it an equally urgent need to define the required qualifications and to produce a syllabus of training.

The position so far reached is that the number of technical authors in employment is known, as is the approximate annual intake of fresh blood. The pre-training qualifications of candidates for technical training as authors are being established by a strong representative Sub-Committee, which will then produce a syllabus for a training course. The representative of the Presentation of Technical Information Group on the Exploratory Committee, Mr. R. Wiltshire, of the British Standards Institution, is also a member of this Sub-Committee.

The feeling of the Exploratory Committee is that some form of apprenticeship may be desirable for the new entry; that, in any case, the technical grounding of the trainee must be sound before he, or she, embarks upon training as a technical author; and that some form of qualifying examination will be required to enable young entrants, as well as entrants of more mature age, such as ex-Service men with technical brackgrounds, to obtain a qualification as practitioners in what is, in fact, a new profession.

The Exploratory Committee would be grateful for the support of the Presentation of Technical Information Group in due course and would, in its turn, be glad to furnish any information which the Group may require. And, of course, Mr. Wiltshire's common membership of both the Group and the Committee will ensure an easy and smooth interchange of ideas.

Yours faithfully,
E. BERTRAM ROWCROFT,
Chairman,
Exploratory Committee on Technical Authorship.
City and Guilds of London Institute,
London, E.C.2.
August 8, 1957.

TOWARDS A UNITED EUROPE

A Five-Year Experiment in Coal and Steel

Concluded from page 188, *August* 9

The first part of this article, published in the issue of August 9 on page 186, described the organisation and discussed the functions of the Community for Coal and Steel set up in 1952 to co-ordinate the activities and promote the growth of these industries in six Western European countries, often referred to as the Messina countries. The activities of the Community's executive body, the High Authority, were examined in three main fields: the removal of obstacles to trade within the Community (Common Market); the encouragement given to re-organisation in the steel industry (Steel Makers Adapt Themselves); and the influence exercised over the use and supply of raw materials (Problems of Ore and Scrap).

This second part of the article is a brief account of the High Authority's activities in the field of technical research and in promoting a common policy in respect of the training, welfare and health of the Community's 522,000 employees.

MAJOR TECHNICAL DEVELOPMENTS

The Community's technical research programme is greatly influenced by the main objectives for the development of the industry. These are to restore the equilibrium between the output of pig iron and that of steel, which is a current problem; to economise in the use of iron ore, to reduce the severe impact on production its shortage is expected to have after 1960; and finally to promote every possible economy in the use of coke. In addition, the High Authority is concerned with any other aspect of technical research which is likely to play a part in the realisation of the steel industry's long-term expansion plans. This, according to the High Authority's Fifth Annual Report, "depends largely on the progress made in scientific and technical knowledge and on the speed with which such knowledge is applied in practice on the broadest possible front." The High Authority has therefore undertaken to co-ordinate and direct research work and to make the results freely available among member firms. It has been able to influence the direction of research into specific channels by making financial grants of a contributory nature but on a substantial scale.

In order to balance the ratio of pig iron to crude steel (the present unbalance places an unbearable strain on available supplies of scrap) the High Authority is actively promoting the expansion of pig-iron production capacity and research into the more efficient production of pig iron and its greater use in steel making. Considerable attention is being paid to the development of steel-making processes based on the use of pig iron, such as the greater use of converters; the blowing of oxygen, of oxygen/steam or of oxygen/carbon-dioxide mixtures; the promotion of the Linz-Donawitz process, which consists of blowing in oxygen under very high pressure from the top of the converter (involving relatively low capital investment and making possible the effective treatment of hematite or low-phosphorous iron); the promotion of the Perrin process, which improves the quality of steels by mixing them with a compounded slag melted in an electric furnace; and finally by the development of the conversion of basic-Bessemer pig iron by the use of an oxygen-fed rotary furnace. The anticipated results of the High Authority's promotion of such developments can be seen in the accompanying table, expressed in percentages of total steel production in the Community.

The saving of coke will be effected by reducing the input of coke in the blast furnaces, by using an enriched burden and by improving sintering, charge preparation and ore enrichment. Another most important development is in the use of low-shaft furnaces to enable the production of metal without using metallurgical coke.

SPONSORED RESEARCH

A necessary condition of the expenditure on research by the High Authority is that the results should be of widespread interest to member firms in all six countries. Another is that the companies who receive the financial assistance should themselves meet the greater part of the total cost. In 1955 the High Authority's total expenditures on research in steel making amounted to 1·58 million dols. (dollar units of account). Two-thirds of this was allocated to the Dillinger steel works in the Saar as a contribution to the cost of making comparative tests between the hard cokes of the Ruhr and the softer cokes made from inferior coking coals.

Among other projects sanctioned in 1955 were a study of rolling mill techniques, research in the properties of silica refractories and a study of flame radiation. Some 200,000 dols. were allotted to the rolling mill project, the specific objects of which were to determine, through the investigation, steel behaviour under identical processes carried out in different rolling mills and to isolate the contributory factors to the formation and adherence of scale. The report in this study is expected to be published shortly.

The grant towards a study of the refractory properties of silica bricks amounted to 278,000 dols. for a project which included systematic trials in four open-hearth furnaces. The research in flame radiation arose from the work of an international committee set up in 1948 to promote the more efficient use of fuels employed in various industries, particularly steel. The High Authority allocated 105,000 dols. in order to accelerate progress in the construction of an experimental furnace.

In June last year the High Authority started a major programme of research, of which the principal project was a study of coke utilisation to be carried out in a low-shaft furnace in Liège, financed jointly by the United Kingdom, France and Italy. The furnace will be operating as a blast furnace on a reduced scale and in this manner should enable each trial to be conducted in less time and at lower cost. A further 650,000 dols. will be allocated to research projects, undertaken by firms or by research associations, on the use of coke in order to increase its efficiency and to minimise consumption. The acute shortage of good coking fines is leading the High Authority to promote the use of sintering, but this is a well-known process and there is little point in further research. It exercises its influence by the use of its capital resources for the financing or assistance of schemes involving sintering plants.

The provision for technical research in the High Authority's budget estimate for the year ending June 30, 1958, amounts to 9·15 million dols. compared with 22·25 million dols. for re-adaptation (mainly of personnel). Expenditure, on the other hand, is not expected to exceed 5·75 million dols. for research and 6·35 million dols. for re-adaptation measures (reviewed briefly below). Compared with a total estimated expenditure of 30 million dols. the amount allocated to research—less than a fifth—appears very modest, particularly as it includes expenditure on coal as well as steel.

Process	Output		Output forecast	
	1952	1956	1958	1960
Basic Bessemer	54·8	51·8	49	49
L. D. Rotor	—	—	1	3
Open-hearth	36·6	38·9	38	36
Electric, Bessemer and others	8·6	9·3	12	12

Questioned on the subject of research sponsored by the High Authority, officials pointed out that a good many steel works were very backward and inefficient, and that technical developments generally lagged behind those in the United Kingdom and the United States. The limiting factor at present lies more in the availability of technicians than in the provision of finance. They considered that there has been a considerable improvement in the sharing of industrial information between member firms, and that greater benefits are being derived from the experience and research carried out in other countries.

The High Authority sent a group of steel experts drawn from the industries of the six countries to the United States in March and April of last year to study American methods of steel-works management. On the whole the activities of this kind, and the effective liaison the United States, Britain, Japan and other countries maintain with the High Authority through their permanent missions ensure that firms are kept in close touch with developments in the steel industries of all these countries. On the question of management, however, the High Authority limit their functions to that of informants. They have no organisation and methods division and have no intention to act in this capacity.

SOCIAL POLICY

Another aspect of the research undertaken under the High Authority's auspices and for which funds are made available concerns the health and working conditions of employees. Among the many projects undertaken, two outstanding studies were on silicosis and on work at high temperatures. Altogether in the field of works hygiene some 70 projects have been undertaken since the end of 1955 and 570,000 dols. spent on them. The problems of accidents at work have also enjoyed a great deal of the High Authority's attention and taken up their full share of available resources.

The High Authority must, under its treaty,

(*a*) to help to increase employment and to raise the standard of living in the member states through the operation of a common market; and

(*b*) to safeguard the continuity of employment and to bring about, step by step, a rise in productivity to the highest level realisable.

This has meant that the High Authority has contributed to the cost of workers' housing, to enable the works to take on increasing numbers and to provide good living conditions. This process is going ahead and at April 1 this year allowance had been made for the financing of nearly 15,000 dwellings of which some 4,000 had been completed and nearly 6,000 were under construction. Over two-thirds of the total were located in Western Germany. The cost to the High Authority of their second experimental building programme for workers' dwellings, including 2,000 dwellings, amounted to 1 million dols. subsidy and 3 million dols. loan.

Another most important aspect of the High Authority's social function is the organisation and partial financing of the "re-adaptation" of personnel in cases of redundancy through works closing down or the introduction of new processes. Some 10·6 million dols. had been loaned from 1952 to the end of 1956 and about 2·6 million dols. actually spent. Some examples of the work done in France and Italy were given in the *Bulletin* from the European Community for Coal and Steel for July-August, 1957, and further information is contained in the High Authority's fifth report, published recently. This is likely to develop into one of the major activities of the High Authority and is one of the more interesting features of the working of this organisation. Though provided with many supra-national powers, the High Authority is very shy to use them but is giving an example in social conduct which might profitably be copied by industry at large.

OIL AND ABRASION-RESISTING RUBBERS IN ENGINEERING

By S. E. Bolam, A.N.C.R.T., A.I.R.I.*

The news that oil-resisting rubbers are to be manufactured in the United Kingdom is of importance to the engineering industry as this means that supplies of these materials will not now be dependent on the dollar situation nor on the fluctuations of the home demand in the United States.

One class of these oil-resisting materials, the Hycar nitrile rubbers, manufactured by British Geon Limited, Devonshire House, Piccadilly, London, W.1, are used extensively for such products as O-rings, U-rings, seals, gaskets, hydraulic packings, engine mountings, and valves; in fact, for any application in which rubber comes in contact with oil. These rubbers, however, are not a panacea for all mechanical lubrication troubles and, like all matter, have certain limitations. It is the purpose of this article to describe the properties of these materials in order to provide engineers with a clear picture of what nitrile rubbers can and cannot do.

Nitrile rubbers are combinations of two chemicals: butadiene derived from oil, and acrylonitrile derived from acetylene and hydrogen cyanide. Originally the chemicals are in a gaseous or liquid state but they are induced to link together to form long chains. As the lengths of these chains grow, so the product passes from a gaseous to a liquid and finally to the solid state. This process is called polymerisation. The mechanical properties of the material improve as the chain length of polymer increases or, in other words, as the molecular weight increases. If, however, the molecular weight is too high, the material becomes too difficult to work in rubber manufacturing machinery.

The all-important property of oil resistance is conferred by the amount of acrylonitrile present in the material. Unfortunately other desirable properties are adversely affected, resistance to low temperatures and resilience being the most important. Thus it is usual to compromise between oil resistance, on the one hand, and low temperature resistance, on the other, and to-day a range of nitrile rubbers are manufactured, with the acrylonitrile content varying between 18 and 45 per cent.

In their raw state these rubbers are of no use as engineering materials; they must first be modified by the addition of various ingredients, such as reinforcing fillers, softeners and vulcanising agents. They are then fabricated or moulded to the required shape and vulcanised to impart strength, resilience and oil resistance, the final properties of the component being capable of considerable modification by the compounding techniques employed.

OIL RESISTANCE

Oils generally attack rubbers by causing them to swell, thus distorting their shape and weakening their strength. This attack is usually an attempt on the part of the oil to dissolve the rubber and is caused by a chemical affinity between the rubber molecule and the oil molecules. Naturally it follows that the extent of the attack depends on the nature of the rubber and that of the oil or solvent. To illustrate the resistance of nitrile rubbers to swelling in oils the following data show the percentage volume increase of a component made from natural rubber and a high-acrylonitrile content nitrile rubber.

As already indicated nitrile rubbers are not resistant to all types of oils and solvents. In general they are resistant to the aliphatic and aromatic hydrocarbons, mineral oils and some synthetic lubricating oils but are swollen by chlorinated hydrocarbons such as ethylene dichloride, and by ketones. They are unaffected by a wide range of chemicals and most acids, except the strongly-oxidising types. Table I (page 203) gives a range of oils, solvents and chemicals and an indication is given of whether nitrile rubbers are recommended for use in contact with them.

Material	Lubricating oil	Petrol
Natural rubber	110 per cent.	220 per cent.
Nitrile rubber	4 ,,	15 ,,

The effect of varying the acrylonitrile content of the material can be seen in Fig. 1. Here the percentage volume change is given for four types of nitrile rubbers after immersion for 24 hours at 40 deg. C. in petrol and 7 days at 70 deg. C. in lubricating oil. One series of tests was based on compounds containing no added softeners. Sometimes it will be found that a shrinkage occurs. This is due to the fact that the immersion fluid leaches out softener which may be present in the compound. This effect can cause trouble particularly in a component which is intermittently in contact with the fluid. The replacement of the softener by the immersion fluid—if the fluid is volatile and thus able to evaporate from the article—can cause a reduction in the size of the component. Should the component be a precision one, failure may occur owing to the increase in stress caused.

The shrinkage caused by the loss of softener is also shown in Fig. 1 where, in a second series of tests, compounds containing 20 parts of softener per 100 parts of rubber were immersed in petrol, and dried for 15 hours at 105 deg. C. It will be seen that the less oil-resisting the rubber, the greater the shrinkage. It is also shown that the volume swell is less when a softener is present because of loss by leaching. Sometimes this effect is used to advantage. Small quantities of softener are purposely incorporated so that they are available for leaching out in order that the overall increase in volume may be curtailed.

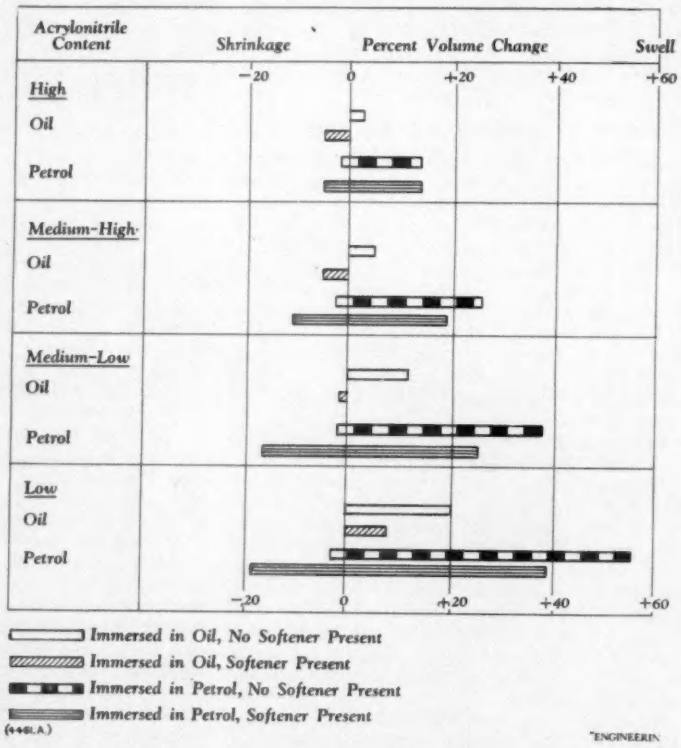

Fig. 1 Effect of oil and petrol on the volume change of nitrile rubbers.

LOW-TEMPERATURE FLEXIBILITY

For many applications oil-resisting rubbers are required to remain flexible at sub-zero temperature. This is particularly true for components employed in aircraft. The effect of decreasing temperature on all rubbers is to cause a loss of flexibility until a stage is reached when the material has lost all resemblance to a rubber and becomes a hard brittle substance. This is analogous to the increase in viscosity experienced with lubricating oils or the conversion of steam, via water to ice and is, in effect, a slowing down of the molecular vibrations of the material, a

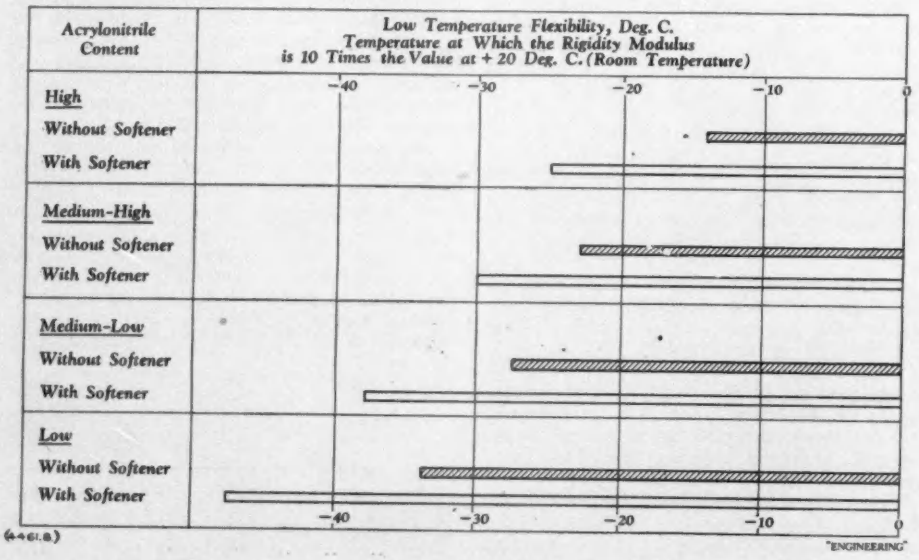

Fig. 2 Low-temperature flexibility of Hycar nitrile rubbers.

* Of British Geon Limited.

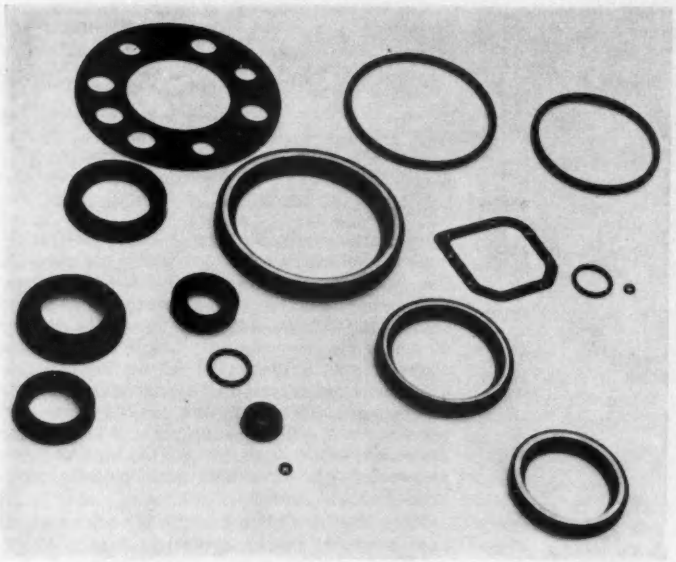

Fig. 3 A selection of oil seals and gaskets moulded from nitrile rubber.

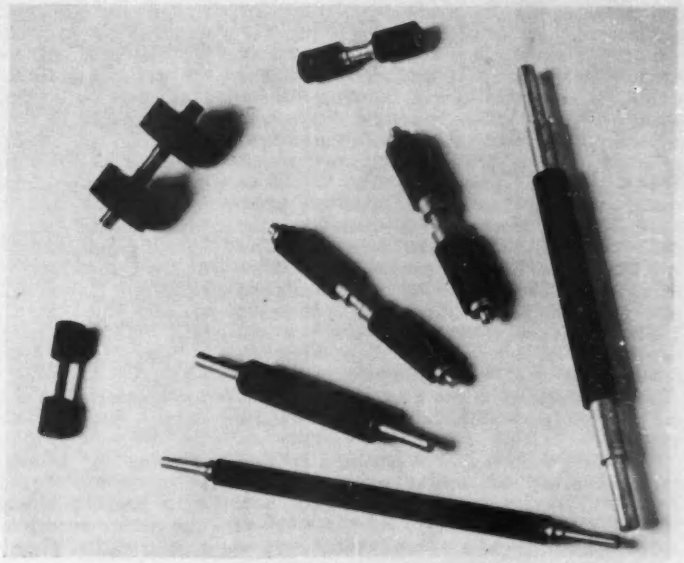

Fig. 4 Examples of textile spinning cots manufactured from nitrile rubber.

TABLE I.—*General Immersion Guide for Hycar Nitrile Rubbers* This table indicates the effect of immersion on typical high and medium-high acrylonitrile rubbers in a number of common industrial chemicals. The tests were conducted at room temperature for 90 days and at 70 deg. C. for 60 days. The recommendations are based, arbitrarily on a maximum change in volume of 30 per cent. Satisfactory service is indicated by "R," unsatisfactory by "NR," and where further checks, under actual service conditions are necessary, by "X."

Media	Acrylonitrile content			
	High		Medium-high	
	R.T.	70 deg. C.	R.T.	70 deg. C.
Acids Inorganic				
Hydrochloric, 20 per cent.	R	R	R	R
Nitric, 20 per cent.	R	X	R	X
Nitric, 40 per cent.	NR	NR	NR	NR
Phosphoric, 20 per cent.	R	R	R	R
Sulphuric, 56 per cent.	R	X	R	X
Alcohols				
Butyl Alcohol	R	R	R	R
Ethylene glycol	R	R	R	R
Glycerol	R	R	R	R
Aldehydes				
Acetaldehyde	NR	NR	NR	NR
Benzaldehyde	NR	NR	NR	NR
Formaldehyde, 40 per cent.	R	X	R	X
Amines				
Ethanolamine	R	R	R	R
Triethanolamine	R	R	R	R
Esters				
Phosphate, Tributyl	NR	N R	NR	NR
Phthalate, Dioctyl	R	R	X	X
Esters				
Ethyl	R	—	R	—
Isopropyl	R	—	R	—
Hydrocarbons				
Benzene	NR	NR	NR	NR
Butane (Liquefied)	R	—	R	—
Diphenyl	NR	NR	NR	NR
Diphenyl Oxide	NR	NR	NR	NR
Dowtherm	NR	NR	NR	NR
Ethyl Benzene	NR	NR	NR	NR
Petrol	R	R	R	R
Petrol (100 Octane)	R	R	R	R
Hexane	R	—	R	—
Hydraulic Oil	R	R	R	R
Paraffin	R	R	R	R
Naphtha	R	R	R	R
Naphthalene	NR	NR	NR	NR
Pine Oil	R	NR	NR	NR
Styrene	NR	NR	NR	NR
Toluene	NR	NR	NR	NR
Turpentine	R	R	R	R
Xylene	NR	NR	NR	NR
Halogenated Hydrocarbons				
Benzyl Chloride	NR	NR	NR	NR
Carbon Tetrachloride	R	R	X	X
Ethylene Dichloride	NR	NR	NR	NR
Ketones	NR	NR	NR	NR
Nitrogen Derivatives				
Acetamide	R	R	R	R
Ammonia (Liquefied)	R	—	R	—
Aniline Oil	NR	NR	NR	NR
Nitrobenzene	NR	NR	NR	NR
Oils, Vegetable				
Castor	R	R	R	R
Cottonseed	R	R	R	R
Linseed	R	R	R	R
Phenols				
Cresol	NR	NR	NR	NR
Phenol	NR	NR	NR	NR

phenomenon which is common to all matter.

The low-temperature resistance of nitrile rubbers is worse than that of natural rubber and is dependent on the acrylonitrile content. Thus if very low-temperature performance is essential some sacrifice in oil resistance may be unavoidable. Sometimes low-temperature flexibility is enhanced by the effect of the immersion fluid and a high acrylonitrile polymer can remain operative at temperatures as low as — 70 deg. C. when in contact with lubricating oil, whereas — 20 to — 30 deg. C. is the usual limit for the material in air. The inclusion of softeners also tends to depress the temperature at which the material stiffens, but this procedure can be accompanied by the leaching out of the softener by the fluid. Fig. 2 shows the effect of acrylonitrile content on this property: the effect of adding a softener can also be seen. In the test the "freeze point" is taken to be that at which the rigidity modulus is 10 times its value at 20 deg. C.*

TENSION STRENGTH AND HARDNESS

Tension strength is normally taken to represent the overall strength of the material and is often used as a criterion of quality. Although the test leaves much to be desired it is a useful test to ensure that a quality product is being supplied, although of course tests more akin to the actual service conditions are to be preferred.

In general, the highest tension strength is exhibited by the high-acrylonitrile rubbers. This is normally between 2,000 to 4,000 lb. per sq. in., measured on the original cross-section. Considerably higher values would be obtained if the cross-section of the material were ascertained at its point of rupture. For the low-acrylonitrile rubbers, values of 1,500 to 3,000 lb. per sq. in. are usual.

Tension strength depends considerably on the ingredients incorporated during the compounding stage. Large quantities of inert fillers tend to decrease the strength while limited amounts of reinforcing fillers, such as carbon black, increase it. The incorporation of softeners also tends to lower the strength. It is, however, important that reinforcing fillers are used for, without such fillers, the strength of nitrile rubbers is very low approximately 1,000 lb. per sq. in.

The hardness range, as measured by the indentation of a spherical ball $\frac{1}{2}$ in. in diameter under a load of 565 grammes can vary between about 10 and 100 B.S. Degrees, where 100 is zero indentation, i.e., the hardness of ebonite. Thus it is possible to meet the majority of hardness requirements.

COMPRESSION SET AND RESILIENCE

The resistance to compression set of nitrile rubbers is excellent and although there is a tendency for the higher-acrylonitrile grades to be slightly better, there is not a marked difference between the various grades. Normally high-acrylonitrile grades will give a set of less than 4 per cent. and the lower-nitrile rubbers of about 6 per cent. Naturally the set characteristics depend upon the conditions of service, i.e. time, temperature and the load imposed. The values quoted above were obtained by compressing the specimen by 30 per cent. for 24 hours at 70 deg. C. and allowing a recovery period of 10 minutes before recording the set.

The resilience of nitrile rubbers is less than that of natural and some other synthetic rubbers and generally lies between 40 and 60 per cent., when tested at 50 deg. C. using the Dunlop Tripsometer* test. This somewhat low value for a rubber means that the energy and shock-absorbing qualities of nitrile rubbers make their use ideal for such applications as engine mountings and shock absorbers. Naturally, for such uses, the good compression-set characteristics are also of great importance. Many materials have good shock-absorbing characteristics but are useless where a load of any size has to be carried.

The resilience of nitrile rubbers is affected by the acrylonitrile content of the rubbers, materials of lower acrylonitrile content being slightly more resilient under comparable conditions.

WEATHERING PROPERTIES AND SERVICE TEMPERATURE

As is well known the majority of rubbers, whether natural or synthetic, are degraded by outdoor exposure and high temperatures. Some types of rubbers are superior to others. Normally, nitrile rubbers are better than natural rubber in their ability to resist the effect of sunlight and ozone but are inferior to synthetic rubbers, such as polychloroprene (Neoprene), polyacrylate and plastics such as PVC. Thus they are not nowadays extensively used for applications which entail extensive exposure to weathering nor where an accumulation of ozone is likely, i.e. as terminal covers on electrical equipment. The heat-ageing properties of nitrile rubbers are, however, excellent and, depending on the actual conditions of service, nitrile rubbers can be satisfactorily employed at temperatures of up to 150 deg. C.

MISCELLANEOUS PROPERTIES

The coefficient of linear expansion of nitrile rubbers depends to a certain extent on the actual constitution of the compound but usually falls between the limits of 0·00043 to 0·000095 in. per in. per deg. F. This is an exceedingly high value when compared with metals, and due

* See British Standard 903:1950, page 144.

* See British Standard 903:1950, page 139.

allowance should be made when designing components.

In this connection it is necessary to stress an apparently anomalous phenomenon and one which has been the source of many service failures of rotary seals. It is this. When heat is applied to rubber, particularly in the stressed condition, it contracts setting up internal strains. This is called the Joule effect. Thus, it will be realised that if a rotary seal is fitted too tightly to the shaft, frictional heat is generated as the shaft rotates and the rubber contracts. This again creates additional frictional heat and the effect is intensified. The cycle is repeated again and again until the seal fails, usually by cracking. Under conditions of high shaft speeds a seal can fail in a few minutes. This premature failure is avoided by designing the seal to be slightly oversize; as little as a few thousandths of an inch on the inside diameter can cure this trouble.

The nitrile rubbers do not possess good electrical insulation properties; values of 1 to 5×10^{10} ohm. cm. volume resistivity are usual with a dielectric constant, at 60 cycles, of approximately 20 and a power factor (60 cycles) of about 0·3. Thus these materials are seldom used for insulation purposes although they are employed as sheathing for wires and cables which are likely to come in contact with oils and solvents.

The low electrical properties, for certain applications, are an advantage for it is possible to reduce the volume resistivity by proper compounding to as low as 100 ohm. cm. thus making the material practically conductive. This is of particular value for applications in which the prevention of the accumulation of static electricity is desirable if not essential. Hoses and conveyor and V-belts are examples of this type of application.

Occasionally, resistance to the permeation of air and gases is of importance and nitrile rubbers, although not as good as butyl rubber, have a high degree of resistance. The values vary with the acrylonitrile content, as shown in Table II; the higher the acrylonitrile content the greater the resistance to the passage of gases. This property, combined with the excellent oil resistance of the materials, has revolutionised hydraulic accumulator design. Normally, a weight-loaded accumulator is used in the hydraulic line but a device developed in the United States, termed the Greer-Mercier accumulator, dispenses with the need for bulky equipment. Basically, the unit consists of a cylinder fitted with a nitrile-rubber bladder filled with a gas under pressure. This cylinder is fitted into the hydraulic system and charged with gas at a pressure, dependent on the working requirements of the line. When the valve is opened, the nitrile-rubber bag expands pushing the hydraulic fluid out of the cylinder, thus applying the pressure. On account of the compactness of the unit and its greater efficiency, much smaller pumps are required. This principle also works in reverse and this type of unit is employed for absorbing shock waves which occur in high-pressure piping systems as, for example, in aircraft fuel lines.

TABLE II.—*Permeability of Nitrile Rubbers to Various Gases*
(Measured as cc. per sq. cm., per second, per atmosphere difference in pressure 10^{-3} at 25 deg. C.)

Acrylonitrile content	Carbon dioxide	Hydrogen	Nitrogen	Oxygen
High	5·67	5·42	0·179	0·73
Medium-high ..	14·1	8·97	0·46	1·78
Medium-low ..	23·5	12·1	0·81	2·94
Low	48·2	19·2	1·92	6·23

APPLICATIONS

Nearly all mechanical units to-day employ nitrile rubbers mainly as O-rings, oil seals and gaskets, and a selection is shown in Fig. 3. The aircraft industry, with its unique conditions of service, employs many components which depend for their successful and trouble-free operation upon efficient nitrile-rubber seals for isolating lubricating fluids whether in a hydraulic system or not. The undercarriage mechanism employs a number of such seals. Additionally, nitrile rubbers are used in fuel hoses on the engines and in the form of adhesives for bonding many parts of the fuselage. The outstanding resistance of nitrile rubbers to petrol has allowed the development of crash-proof flexible petrol tanks which are now generally used in military aircraft. This type of tank minimises the danger of petrol escaping should a crash occur. The vibration characteristics of nitrile rubbers are used to advantage in vibration-dampening brackets used for supporting cabin pressurising superchargers. Here, in addition to supporting the weight of the supercharger, the bracket must absorb the vibration and strain developed during take-offs and landings.

Naturally, as nitrile rubbers are oil-resistant, their extensive use in oil-well drilling is to be expected. In this sphere, nitrile rubbers find a wide field of applications ranging from minute valves to large-diameter flexible hose. In industry, as a whole, nitrile rubber hoses and fuel pipes are widely used. In this category sizes range from small couplings on the internal-combustion engine to giant de-fuelling pipes used on oil tankers. Abrasion resistance is an important adjunct to oil resistance in this use.

The textile industry also employs nitrile-rubber components, mainly in spinning cots and draft aprons. Again, in this application, abrasion resistance is of paramount importance. Some examples of textile spinning cots manufactured from Hycar nitrile rubber by the Armstrong Cork Company, Limited, are seen in Fig. 4.

FURNACES FOR THE ALUMINIUM DIE-CASTING TRADE

Two furnaces, one electric and the other oil-fired, have been placed on the market by the Morgan Crucible Company, Limited, Battersea Church-road, London, S.W.11. Both have been designed specially for the aluminium die-casting industry. Developed as a result of collaboration between the Morgan Crucible Company, Limited, and Birlec Limited, Tyburn-road, Erdington, Birmingham, 24, the type EDF (electric die-casting furnace) is a 300 lb. (135 kg.) electric heating furnace for maintaining aluminium and aluminium alloys in the molten state at temperatures of up to 800 deg. C. It combines the proved advantages of crucible melting with the undoubted benefits of electric heating.

It is equipped with automatic temperature control gear, which maintains the metal at the casting temperature and avoids variations in metal quality. Moreover, by fitting an automatic time switch, the furnace can be started up before the normal working time and be ready for instant use at the commencement of a working day or shift. A foot-operated insulated furnace cover shown in use in the accompanying illustration, reduces operator fatigue and effectively prevents the radiation of heat. If desired, however, a hand-operated cover can be fitted.

The furnace rating is approximately 25 kW, and the lining consists of an outer layer of insulating slabs and two inner layers of refractory insulating bricks. The hot face is of moulded refractory bricks forming heating-element carriers, manufactured by an associated company, Coupe and Tidman Limited. The heating elements are of nickel-chromium alloy wire, in coil formation, with lead-out rods through the furnace brickwork to external teminals which are provided with a ventilated guard. The life of the elements is estimated to be from 1½ to 2 years.

The automatic temperature control gear works on the on-off principle by means of a constantly-immersed Chromel-Alumel thermocouple protected by a mullite-silicon carbide composite sheath. The temperature indicator controller is of the millivoltmeter type and a Pyrolimit indicator is fitted to prevent the elements rising above the safe temperature. Both instruments have a broken thermocouple safety device which interrupts the power supply. Manual operation is provided against instrument or couple failure overriding the automatic temperature control gear, but not the element safety device. The

Fig. 1 (left) Birlec-Morgan bale-out electric die-casting furnace, type EDF Mark I, showing the pedal operation of the insulated furnace cover. The capacity is 300 lb. of aluminium.

Fig. 2 (right) Oil-fired basin hydraulic-tilting crucible furnace which is completely floor mounted; no excavation work is needed prior to installation. The capacity is 380 lb. of aluminium.

instruments are mounted in a control cabinet adjoining the furnace and in which are housed all the necessary pilot lights, control circuit fuses, contactor panel and moulded oil-immersed circuit breaker.

The melting time, from cold to 720 deg. C., for a charge of 300 lb. of aluminium, is 6 hours, and the power consumption for maintaining 300 lb. of aluminium at 720 deg. C. is 9 kW/hours. The temperature is controlled at ±5 deg. C. A maximum working throughput of 80 lb. per hour can be achieved at the full rating of 25 kW/hours. Removing 10 lb. of molten metal and charging 10 lb. of solid metal at 8-minute intervals gives a temperature fluctuation of 15 deg. C.

Complementary to the EDF furnace is the oil-fired basin tilting furnace shown opposite. This is intended as a feeder for the maintaining furnace and has a capacity of 380 lb. (170 kg.) of aluminium. The furnace uses a spouted basin-shaped crucible which facilitates the charging of ingot or scrap metal. A special feature of the furnace is the built-in hydraulic tilting mechanism. This gives smooth lip axis pouring with finger-tip control. Specially designed hydraulic rams obviate the necessity for the excavations of deep ram pits; moreover, as a modern spilt-metal tray replaces the conventional pit, the furnace is completely "floor mounted" and no excavating work is needed prior to its installation.

The furnace is fitted with the firm's LST Mark II low-pressure oil burner which can be easily swung away to allow inspection of the firing tunnel to be carried out. The furnace requires 250 cub. ft. of air per minute at a water-gauge pressure of 4 in. A Tri-Mor high-temperature Castable lining is fitted and this is backed with insulating brick. This combination ensures cool working conditions, high performance and maximum life.

On the first heat, the bringing of 380 lb. of aluminium to 720 deg. C., takes 50 minutes from lighting the burner, subsequent heats of 380 lb. take 30 minutes. Some 11¼ lb. of fuel oil are consumed per 100 lb. of metal melted.

HYDRO-REFINING COAL-TAR PRODUCTS

It is announced that Newton, Chambers and Company, Limited, Thorncliffe, near Sheffield, have concluded an agreement with the Coal Tar Research Association for the commercial development of the Association's process for the hydro-refining of crude benzole, naphthas and other hydrocarbon oils. This process is the result of research carried out by the Association since 1952; it employs pure hydrogen or hydrogen-containing gases such as coal gas or coke-oven gas, in combination with a catalyst for the preferential hydrogenolysis of sulphur compounds, gum-forming olefines and colour-forming bodies, and the process gives a substantially theoretical yield of refined products. The new C.T.R.A. hydro-refining process has been developed for continuous operation which can be completely automatic to ensure that the refined product or products are consistently in accordance with the prescribed specification.

At the present time the refining of benzoles and naphthas is carried out almost universally by using a batch intermittent process of agitation with strong sulphuric acid. In addition to the somewhat uncertain results, the acid washing process results in considerable losses of spirit, and the production of "acid tar," the disposal of which is extremely difficult. Moreover, naphthas cannot always be satisfactorily refined by washing with strong sulphuric acid.

The C.T.R.A. process differs from other hydro-refining processes for crude benzole by employing a considerably shorter contact time, thus giving a higher output for a given size of converter. Moreover, the process operates at considerably lower pressures for naphtha refining. This last point will be recognised to be of particular importance since the consumption of hydrogen in naphtha refining is considerably reduced with consequent savings, and the undesirable conversion of aromatics to naphthenic hydrocarbons is minimised.

The choice of hydrogenating gas and the general operating conditions best suited for the desulphurisation of a particular feed stock, or range of feed stocks, can at present be quickly ascertained in a small laboratory-scale unit. In addition to these facilities, a pilot plant capable of dealing with 500 gallons of feed stock per day has been erected at the Thorncliffe Works of Newton, Chambers, which firm informs us that they will welcome inquiries for the design and construction of plants for the hydro-refining of coal-tar products. The pilot plant will be used to determine the optimum operating conditions, together with all chemical-engineering data for any crude benzoles and naphthas. Its capacity is such that the products will be in sufficient quantity for market research or further investigation by interested parties.

It is considered that hydrogenation is of very great potential value as a chemical-engineering tool generally and in the coal-tar industry in particular. In this respect, it is worthy of note that the pilot plant has been designed for wider operating conditions than those required for the hydro-desulphurisation of benzoles and naphthas, so that it can be readily adapted for further investigations and development work in this field.

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LARGE INDUSTRIAL USER OF TOWN GAS

Manufacture of Gas Fittings

The factory of the Yorkshire Copper Works Limited, Leeds, 10, constitutes the largest single consumer of town gas in the area of the North Eastern Gas Board. This statement was made to us during a recent visit to these works, which were founded in 1909 as successors to the Leeds Copper Works Limited, a company established some years previously. The firm has long been known in the United Kingdom and overseas as a manufacturer of copper tubing and fittings and many thousands of feet of its light-gauge copper tubes and hundreds of thousands of its fittings are used annually by the various Gas Boards throughout the United Kingdom, both in domestic and industrial applications. The company's products also find application as condenser tubes in oil tankers and other sea-going ships, as heat exchangers in many industries and as tubes and pipes in the petroleum and many other industries.

The growth of the factory in post-war years has been rapid and now some 4,000 employees work in its shops and offices, which cover approximately 30 acres. This growth is reflected in the company's consumption of gas which has risen from 166,250,000 cub. ft. in 1948 to no less than 472,974,000 cub. ft. in 1955. Although, in 1956, a reduction to 437,367,000 cub. ft. was recorded, it is emphasised that there has been no changeover of equipment to other fuels and this saving in gas is due entirely to the greater economy in the use of gas consumed for space heating, by insulating the buildings, and by making a general reduction in unnecessary air changes.

Large quantities of gas are consumed for the controlled heating of pure-copper and alloy billets up to 12 in. in diameter and weighing as much as 4 or 5 cwt., prior to extrusion by hydraulic presses. Fully automatic annealing, shell-heating and tube-end annealing furnaces are all fired by gas, which fuel is used also for neutral-atmosphere generators and, as indicated above, for space heating.

USES OF TIN

In order to celebrate the 25th anniversary of the foundation of the Tin Research Institute, Fraser-road, Perivale, Greenford, Middlesex, the chairman of the International Tin Research Council recently invited visitors to inspect the laboratories to see some of the work under way and to meet the staff.

So far as was practicable, techniques which have been developed or are employed at the Institute were shown and a noteworthy demonstration was the continuous casting of bronze rods in a machine specially developed at the Institute. In this, a stream of liquid metal accumulates in a gas-heated tun dish, from which it runs into a water-cooled mould and is withdrawn below as a solid rod. The diameter of the rod was 1½ in. and the quality of the material, it is stated, is "supremely good." Tubes are also cast by this method, and following the successful demonstration of the machine at the Institute, several manufacturers of bronze in different countries have built similar machines and have put them into continuous operation.

Motor-car and Diesel-engine bearings shown in the metallurgical laboratory were made from an alloy of aluminium and tin bonded to thin steel strip shells. The aluminium-tin alloy is prepared as a strip which is then welded to the flat steel strips and the composite material is subsequently formed into half shells and accurately machined to fit the engine shafts. It is stated that one of the leading manufacturers of bearings in England is now making steel-backed aluminium-tin bearings containing 20 per cent. of tin.

Much of the world's tin is consumed as corrosion-protective coatings for steel and other metals and at the Institute demonstrations were given of the improved techniques which have been developed for applying tin coatings to such objects as cast-iron mincing machines and steel milk churns. A recently-developed coating, tin-nickel alloy electroplate, containing two parts of tin to one part of nickel, can be applied to steel, brass, nickel-silver, zinc and other basic metals. It is hard and remarkably resistant to tarnishing and also to attack by many chemicals and food products. These facts recommend it for many uses normally covered by chromium plate and for some uses held by silver. Its permanence even in polluted atmospheres accounts for its adoption as a finish for many kinds of scientific instruments.

Fungicides based on tin chemicals were also on view at the Institute. They are known as organotin compounds and their feature is that each atom of tin is chemically-bonded to three atoms of carbon. These compounds, it appears, are among the most powerful fungicides known and they are now being adopted in the paper and pulp industries and in wood-preservation and water-treatment processes. It is considered likely, moreover, that there can be a considerable future for them in agriculture as pesticides and weed killers.

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HANDLING CARTONS

In order to avoid the expense involved in pallets, whether of wood or of paper, the Industrial Engineering Department of Proctor and Gamble, of Cincinnatti, Ohio, U.S.A., developed hydraulic clamping arms for attachment to a normal lift truck. The arms that operate these clamps will adjust for widths between 20 in. and 70 in., and the clamps themselves have a large contact area to prevent crushing the cartons. Rubber-surfaced faces prevent load slippage. The clamps grip the sides of a batch of cartons, and thereby avoid damage to the bottoms, which might be hidden during storage. If by any chance damage is caused, it is easily visible since it is on the exposed sides. Up to 3,000 lb. weight of cartons can be handled in a single lift. The clamping pressure can be varied to suit the load carried.

CONTROL OF LEVEL

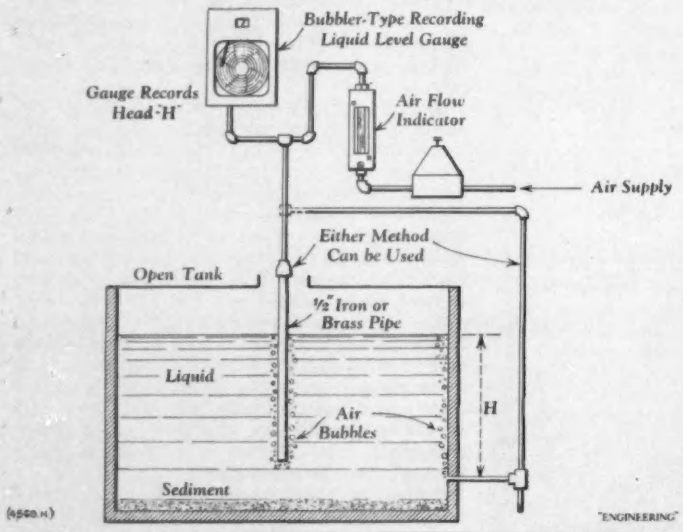
In the first article in this series, published last week, we described techniques for detecting the level of "difficult" materials—solids, molten glass, corrosive liquids, and others—using gamma radiation, electrical capacity and conductivity methods. In the two succeeding articles we deal with the traditional liquid-head and buoyancy methods applied to open vessels and reservoirs, and to closed tanks and pressure vessels.

2—LIQUIDS IN OPEN VESSELS AND RESERVOIRS

For measuring the liquid level in open vessels, the most commonly used methods are the "bubbler" system and the diaphragm box, both of which are based on the measurement of the head of liquid, or the buoyancy type in which the level is indicated directly by the movement of a float on the surface of the liquid.

The "bubbler" method is simple, foolproof and inexpensive, and can be used with dirty, viscous and corrosive fluids, but requires a supply of compressed air, or similar suitable fluid, at a pressure greater than the maximum head of liquid to be measured. An open-end pipe is inserted in the vessel to a point a few inches above the bottom, and a continuous supply of compressed air is "bubbled" through the pipe. The air pressure in the stand pipe then gives a measure of the head of liquid above it, and a tapping from this pipe can be led to an indicating or recording instrument, or to an auxiliary pneumatic controller. Among the firms marketing such instruments are Foxboro-Yoxall Limited, Lombard-road, Morden-road, Merton, London, S.W.19; George Kent Limited, Luton; Negretti and Zambra Limited, 122 Regent-street, London, W.1; Bristol's Instrument Company, Limited, London, S.E.13, whose bubbler recording gauge for ranges up to 300 ft. of water is seen in Fig. 8; and Electroflo Meters Company, Limited, Abbey Park Royal, London, N.W.10, whose "air-reactor type" meter is specially designed for use in boreholes and deep wells. All these firms supply pneumatic controllers which can be used in conjunction with the metering instruments, providing on-off or continuous regulation of the liquid level. Negretti and Zambra also offer an electrical transmission system for remote control up to 3 miles, and Electroflo market a heavier-duty hydraulic regulator which they recommend when large variable-speed pumps are the medium by which the liquid level is maintained; a pressure-measuring element in the regulator is loaded by the air reaction pressure from the bubbler pipe, and the regulator actuates the pump-motor speed control in such a way as to maintain constant pressure.

The diaphragm-box type of instrument can be used for measuring the depth of liquid in an open vessel when no compressed-air supplies are available for operating the simple bubbler-type instrument. These instruments also can be used for liquids carrying solid matter in suspension and for turbulent liquids. The measuring element comprises a pressure chamber bounded on one side by a flexible diaphragm which is subjected to the pressure head of the liquid to be measured; the chamber is connected by an air-filled tube to a pressure-measuring indicator, recorder, or controller. Manufacturers of this type of instrument include the Budenberg Gauge Company, Limited; Bristol's Instrument Company, Limited; Foxboro-Yoxall Limited (Fig. 9); James Gordon and Company, and Negretti and Zambra Limited.



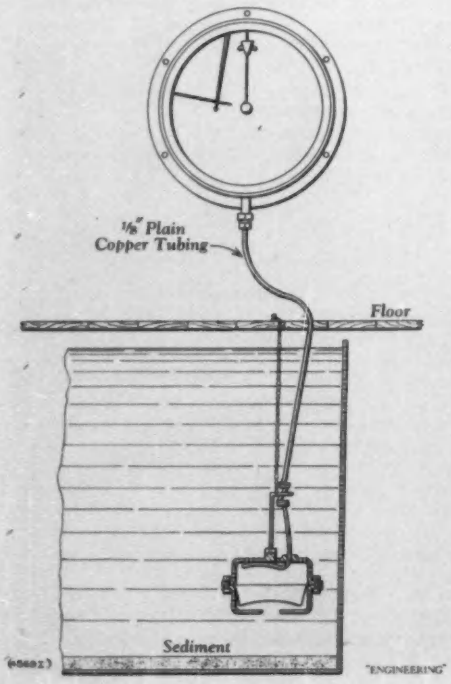


Fig. 8 (above) The "bubbler" type liquid-level instrument by Bristol's Instrument Company, Limited, is available for level ranges from 2 in. to 300 ft. of water. A compressed-air supply at a pressure greater than the maximum liquid head is required to operate this system.

Fig. 9 (left) The diaphragm-box type of instrument uses a pressure chamber bounded on one side by a flexible diaphragm which is subjected to the pressure head of the liquid to be measured. The chamber is connected by an air-filled tube to the indicating, recording or controlling instrument. (Foxboro-Yoxall Limited)

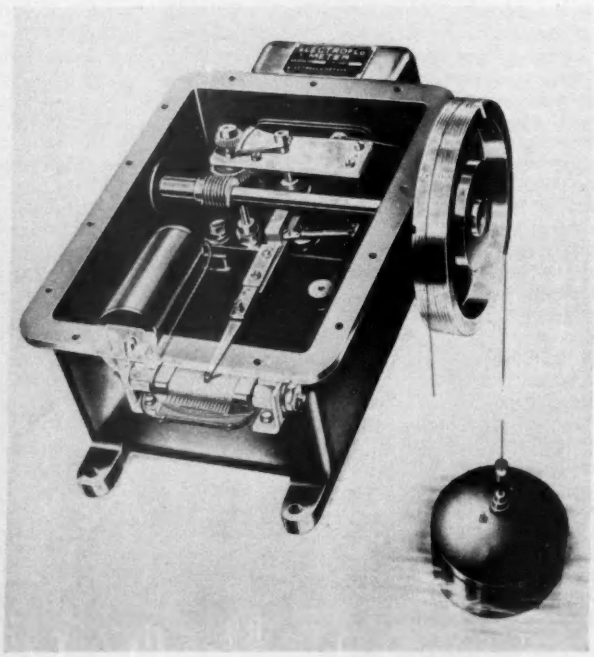


Fig. 10 (right) The Electroflo Series 490 float-operated level meter employs alternating-current transmission to a remote controller. The motion of the flow is followed by a variable resistance in the receiving-instrument circuit.

RESERVOIRS

For measuring liquid level in large-scale open reservoirs and sewage plants and similar applications, probably the most widely used method is that where a float on the surface of the liquid is connected by a cable passing over a drum to a counterweight; movements of the float as the liquid level changes cause the drum to rotate and actuate the indicating or recording mechanism, or auxiliary mechanisms for automatic control. Installations of this type are made by Bristol's Instrument Company, Limited, and by Foxboro-Yoxall Limited, who make two ranges of float and drum assemblies—the low range giving a minimum of 0 to 5 in. and a maximum of 0 to 36 in. travel, and the high range giving a minimum of 0 to 36 in. and a maximum of 0 to 50 ft. travel.

The float-operated level meters made by Electroflo Meters incorporate electrical transmissions as shown in Fig. 10. Three types are available—the series 481, for sumps and underground tanks, operating over any range up to 0 to 25 ft., on alternating current; the series 490 for surface reservoirs and tanks for ranges from 0-6 to 0-25 ft. operating on alternating current; and the series 490-5, a direct-current instrument for the same operating range but for long-distance transmission over telephone lines.

In the series 481 meters, the float movement determines the degree of immersion of a resistance element suspended in a mercury well, and thus determines the conductance of the electrical instrument circuit. Two switches can be incorporated in the transmitter to provide on-off control of a pump motor for regulating the sump level. In the series 490 instruments, the motion of the float is followed by the contact arm of a variable resistance, and up to four switches can

be incorporated in this transmitter. For long-distance control using the direct-current series 490-5 transmitter, electronic instruments are available to provide on-off control of pump motors.

Similar in principle is the float-operated electrical level transmitter by George Kent Limited, for the remote measurement of the variations of water level in rivers, reservoirs and tanks, with a level range from 0 to 20 ft. and from 20 ft. to 48 ft. Alternating or direct current versions are available.

The Telytone transmitter made by Measurement Limited, an associate company of Parkinson and Cowan Instruments, 7-17 Fitzalan-street, Kennington-road, London, S.E.11, is designed specifically for telemetering level indications in surface reservoirs, etc., to a remote recorder and indicator over distances up to six miles, with an accuracy of plus or minus 1 per cent. of full scale. It comprises a float-operated transmitter which can be connected to the G.P.O. telephone system or to private lines. The chart recorder or indicator at the receiving end can be fitted with up to three sets of adjustable control contacts suitable for a current of 3 amperes on 250 volt alternating current, which can be used for controlling pumps or for high or low circuit alarms. The system operates on the principle of the self-balancing Wheatstone bridge, which eliminates the need for any electricity supply at the transmitting point, a great advantage for reservoirs situated in remote or isolated areas.

The Noflote level controller of Evershed and Vignoles Limited, which makes use of the electrical conductivity of the liquid being controlled to actuate a relay operating pump or sluice gate motors, was described in an article published last week.

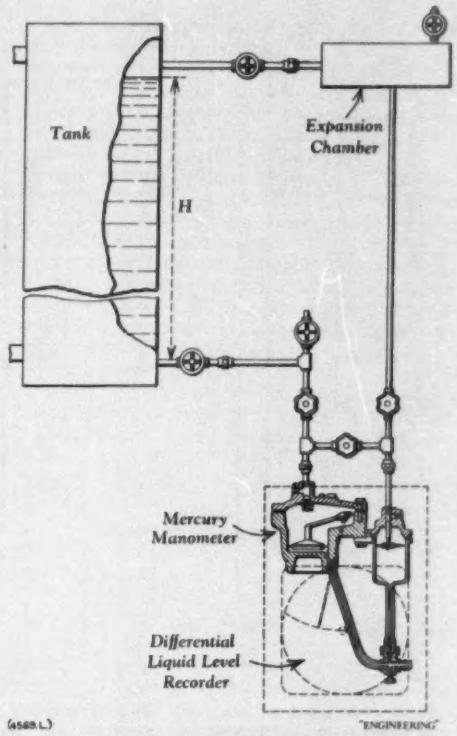


Fig. 11 Mercury-manometer type of differential-pressure liquid-level gauge. The float riding on the mercury level is directly linked to the indicating instrument. Pneumatic transmitter/controllers are most commonly used in conjunction with such instruments. (Bristol's Instrument Company.)

3—LIQUIDS IN CLOSED TANKS AND PRESSURE VESSELS

In closed tanks, which may be under pressure or vacuum, the traditional methods largely in favour for controlling liquid level are based either on the buoyancy of floats or " displacers," or on the measurement of the difference between the pressure in the vapour space above the liquid and the total pressure of vapour plus liquid head. In chemical processes where the interest lies in controlling the level of the interface between two different liquids, the capacity probe method described in last week's article, which has the advantage of specific gravity independence, is extensively adopted now. However, the well-proved buoyancy technique, which makes less sophisticated demands on maintenance personnel, is still in wide use.

One of the attractions of the differential-pressure technique is that many of the components are identical with those of flow-control systems, and in a large plant maintenance procedures are thereby simplified. For measuring the differential pressure, the U-tube mercury manometer probably affords the greatest measure of accuracy. A steel float rests on the mercury in one of the legs and transmits its position through a mechanical linkage to the indicating, recording, or controlling instrument. Generally, pneumatic transmission and/or control is employed in conjunction with manometer-type differential-pressure instruments. Among the many process-control instrumentation manufacturers supplying instruments of this type are Bristol's Instrument Company, Limited, whose standard range covers from 10 in. to 300 in. of water (Fig. 11); Foxboro-Yoxall Limited, with standard instruments up to 200 in. of water; George Kent, Limited, whose " Kux " range of differential-pressure level controllers are available for pressure differences from 25 in. to 600 in. of water and are supplied for working pressures up to 2,000 lb. per sq. in.; and Taylor, Short and Mason Limited, in ranges up to 400 in. of water. Interesting features of the Taylor instruments are the ease of changing the range tubes on the manometer and the use of a Teflon low-friction pressure-tight stuffing box.

A specially designed scheme for the water level control of water-tube boilers has been devised by George Kent. Illustrated diagrammatically in Fig. 12 and known as " three-element " control, the system takes account of feed-water flow, steam flow and drum water-level, all of which must be known for the efficient control of the amount of water in the drum. The system makes use of four air-operated transmitting instruments, a drum-level transmitter of the mercurial U-tube type, specially designed to eliminate errors due to thermal gradients in the pressure pipes; a steam-flow transmitter; a feed-water flow instrument fitted with a computing and transmitting mechanism; and the master instrument of the scheme, a level controller. The steam-flow instrument transmits a pneumatic signal, proportional to the value of steam flow, to the feed-water-flow instrument. The latter measures the water flow and transmits a signal, which represents the difference between steam flow and water flow, to the master level controller. This controller also receives a signal, proportional to level, from the drum-level transmitter.

In the master level controller, the control mechanism operates in response to the difference between the level signal and the steam-flow minus water-flow signal, and sends a corresponding signal to the feed-water regulating valve.

DIAPHRAGM MANOMETERS

If the liquid to be measured is corrosive it is necessary to protect the manometer by filling the connecting lines with a sealing fluid, which is immiscible with the process fluid, using seal chambers at the tappings to ensure a constant head of sealing fluid under all operating conditions. Alternatively a purging system can be used, in which a continuous flow or purging liquid or gas is fed into both high-pressure and low-pressure lines. To avoid this rather cumbersome installation, the mercury manometer can be replaced by an aneroid or a diaphragm manometer, requiring no liquid seals or purging and having the advantage of a faster response at a slight expense in precision. For example, for high-pressure applications Taylor, Short and Mason Limited, market an aneroid-manometer instrument for differential pressure ranges from 0–20 up to 0–500 lb. per sq. in. at a working pressure of 300 lb. per sq. in., and from 0–20 up to 0–500 lb. per sq. in. at a working pressure of 1,500 lb. per sq. in. The movement of the pressure-sensing bellows is transmitted to the indicating, recording or controlling mechanism through a flexible strip and torque tube. For low-pressure applications they produce a diaphragm manometer suitable for measuring differential pressures less than 4 in. of water under a static pressure not exceeding 5 lb. per sq. in.

The " d/p cell " diaphragm-type differential pressure transmitter of Foxboro-Yoxall Limited is typical of a number of systems designed for

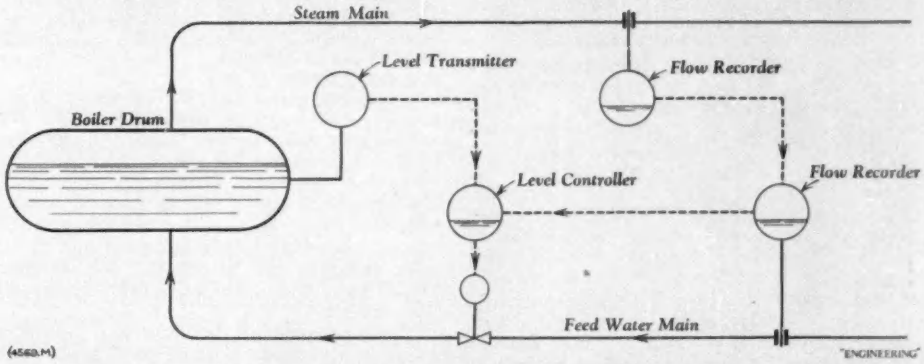


Fig. 12 Kent's " three-element " control scheme for water-tube boilers takes account of feed-water flow, steam flow and drum water-level.

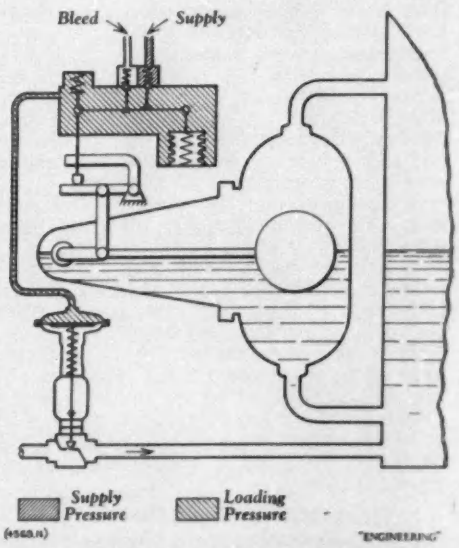


Fig. 13 Ball-float operated pilot valve controlling compressed-air supply to main control valve. (Fisher Governor Company)

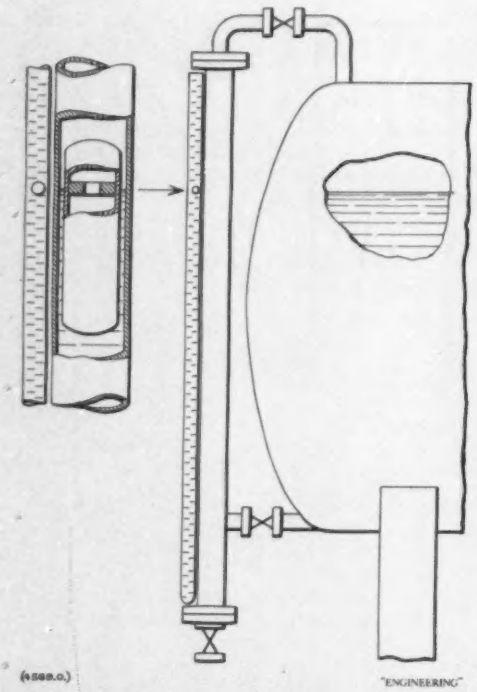


Fig. 14 (left) The Rotameter Ekstrom liquid level indicator employs a magnetic coupling between float and pointer.

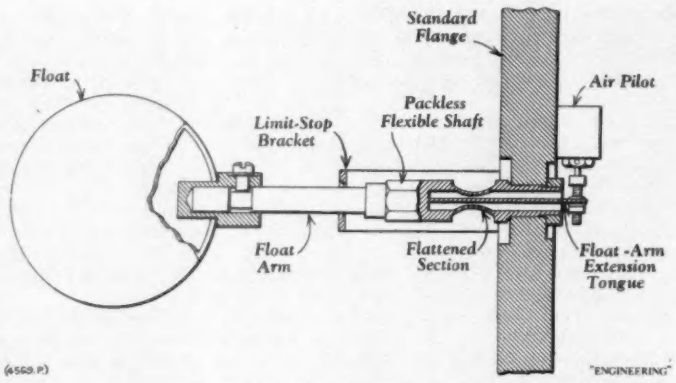


Fig. 15 (top right) The Sunvic liquid-level controller is designed to operate either an air pilot valve controlling a pneumatic controller, or a microswitch for on-off electrical control.

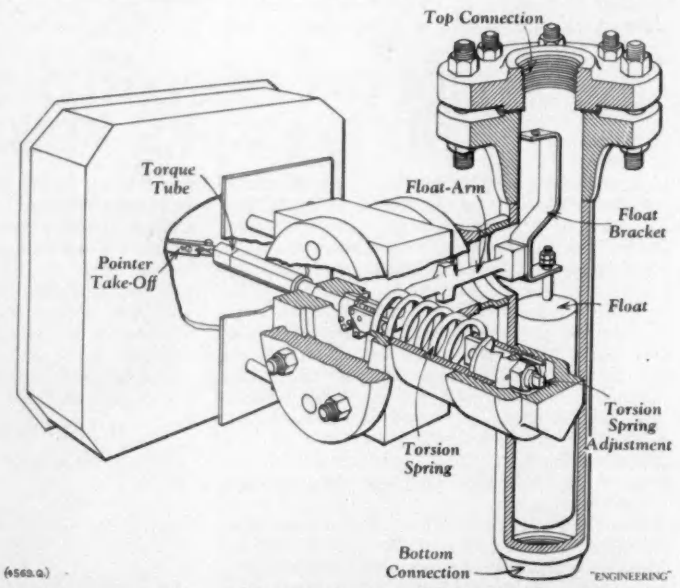


Fig. 16 (lower right) The Taylor, Short and Mason Level-Buoy pneumatic controller, of the "displacer" type in which the "float" is heavier than the liquid in which it is immersed.

transmission to a remotely located receiving controller or instrument. It operates on the force-balance principle, converting differential pressure, which is sensed by a stainless-steel capsule, into a proportional air output pressure. Designed to operate under a maximum working pressure and temperature of 1,500 lb. per sq. in. and 250 deg. F., it is available in differential pressure ranges up to 0-250 in. water.

FLOAT-OPERATED CONTROLLERS

Probably the simplest method for direct control of liquid level in closed tanks is the "float-operated" control valve providing proportional control through a mechanical linkage—equally suitable for open tanks. Instruments of this type are made, among others, by the Drayton Regulator and Instrument Company, Limited, West Drayton, Middlesex, who have equipped several oil refineries with valves of this kind, and the Fisher Governor Company, Limited, Airport Works, Maidstone Works, Rochester, Kent. Generally, the float is installed in a cage outside the liquid-containing vessel, rather than inside, particularly where foaming or disturbance of the liquid surface is likely.

The Fisher range of direct-operated ball-float controllers is available in several types, for various applications such as maintaining a constant liquid level in accumulators, stills, feed-water heaters and receivers, stabiliser columns, fractionating towers, vacuum tanks and piping systems, with float-cage ratings up to 600 lb. per sq. in. and 800 deg. F. or 1,200 lb. per sq. in. and 100 deg. F.; in 8 in. and 10 in. float sizes for standard pressures, and 8 in. only for medium and high pressures. Teflon-packed ball-bearing stuffing boxes are used in the float cage.

A refinement over the direct-operated ball-float valve is the ball-float pilot valve controlling a compressed-air supply as indicated in Fig. 13 to actuate the main control valve. The mechanism can withstand higher pressure changes and pressure drops and gives more sensitive control than direct-operated ball-float controllers. It lends itself to remote control and to adjustment of the proportional band. Equipment of this type is marketed by the Fisher Governor Company, either for two-position or for proportional control or, in their Level-Trol pilot controller, providing a choice of on/off or throttling control.

MAGNETIC COUPLINGS

The conventional float and float-arm mechanism can be adapted to the on-off control of liquid level in pressurised or vacuum tanks, or in storage vessels containing corrosive and high- or low-temperature liquids, by using magnetic couplings to transmit the movement of the float to the switchgear. In the R. and G. instruments made by Bayham Limited, 12 Lower Grosvenor-place, London, S.W.1, one or two independently wired mercury switches can be operated at different levels. This is particularly useful for starting and stopping motorised pumps for replenishing daily service tanks, for instance. In its standard form, the instrument is available for a level differential between 1½ in. to 6 ft. The float is of copper and all parts in contact with the liquid, other than the Alcomax III magnetic coupling, are in gunmetal and brass; other materials can be supplied for corrosive applications, and intrinsically safe instruments are available.

The movement of the float arm rotates a transmitting magnet through bevel gears. For non-lubricating and viscous fluids, a large plate-type gear is used which permits long bearing surfaces and has self-cleaning properties. Where the liquid is likely to contain solid matter, the gears can be totally encased by a detachable cover. Adjustable fingers mounted on an extension of the front magnet trip the mercury switches at predetermined positions when the magnet is rotated. The sensitivity of the instrument depends on the length of the float arm; approximately 10 deg. of arm movement is the minimum setting between the trip and recovery of the mercury switch. The accuracy is approximately ± 2 deg. of float-arm movement.

Of a similar type are the float-operated level alarm switches by Evershed and Vignoles Limited, comprising two mercury switches in a flame-proof head, operated by a stainless-steel float through a magnetic linkage giving a snap action.

Magnetically coupled limit switches for telemetering to remotely situated alarms or controllers are also a feature of the Ekstrom liquid-level indicator (Fig. 14), made in the United Kingdom by the Rotameter Manufacturing Company, Limited, 330 Purley-way, Croydon, Surrey, under licence from Ak.A. Ekstroms Maskinaffar, Stockholm. The Ekstrom indicator, particularly suitable for use with corrosive, toxic and inflammable liquids, and liquid gases under pressure, consists of a tube and float of non-magnetic material and a separate gauge glass with an indicator. Within the float is fixed a strong permanent magnet, the dimensions of the float being chosen so that the field of force of the magnet coincides with the level of the liquid. The indicator comprises a hollow iron sphere 1 in. in diameter, of the same density as the butanol with which the gauge glass is filled.

Particularly recommended by the manufacturers for interface-level control between two liquids whose specific gravity differs by as little as 0·05 is the liquid-level controller by Sunvic Controls Limited, No. 1 Factory, Templesfield, Harlow, Essex, which is available either as a continuous or on/off air-operated controller or as an electrically actuated on-off controller. As shown in Fig. 15, the float is mounted on a short float-arm which is connected to the free end of a Sunvic Packless flexible shaft. The latter has a flattened centre section permitting only vertical float motion. A stiff tongue within the shaft transmits the force to the pilot valve of a pneumatic controller or to a microswitch. The standard instruments are designed for operating temperatures up to 300 deg. F., for pneumatic controllers, or 250 deg. F., for electric controllers. Non-standard instruments are available up to 700 deg. F. (pneumatic) or 500 deg. F. (electric, flameproof) and down to below freezing point on both types. With ball-type floats, the standard pneumatic controllers are available for level changes from $\frac{1}{16}$ in. to $\frac{3}{8}$ in. and from $\frac{1}{4}$ in. to $\frac{5}{8}$ in. (at specific gravity 1·0). With cylindrical floats, proportional action over level changes up to 12 in. is possible.

"DISPLACER" OPERATED TRANSMITTER/CONTROLLERS

For applications in which there may be a considerable change in liquid level over the control range, the variable-displacement type of buoyancy instrument, in which the "displacer" is always heavier than the liquid displaced when fully immersed, is preferable to the float since the movement of the displacer relative to

the liquid level—which depends on the cross-section of the displacer, the specific gravity of the liquid, and the stiffness of the spring supporting the displacer—is substantially less than the actual level movement. In the range of Masoneilan variable-displacement liquid-level controllers manufactured under licence by the Crosby Valve and Engineering Company, Limited, the controller is designed for a constant displacer volume. Level changes from 14 in. to 120 in. can be obtained with standard instruments by using displacers of varying lengths and cross-sectional areas. Masoneilan liquid-level controllers are particularly recommended by the manufacturers as liquid-interface controllers in chemical processes, and are available either as direct controllers or as controller/transmitters for remote control.

In these instruments, the movement of the displacer is transmitted to the control instrument through a torsion tube which is arranged to form a frictionless pressure seal, eliminating any possibility of gland leakage. The torsion tube actuates a pneumatic transmitter or controller, with the possibility of on-off or continuous control adjustment. An unusual feature of the Masoneilan pneumatic controllers is an adjustment enabling the instrument to be set to the specific gravity of the liquid being controlled.

Displacer-type pneumatic controller/transmitters are also made by the Fisher Governor Company, Limited, the main difference between their instruments and the Masoneilan controllers being in the method of transmitting the displacer movement to the pneumatic controller. In the Fisher instrument a Bourdon tube is employed, whereas the Masoneilan controllers use a pneumatic bellows.

The Level-Buoy indicating controller or transmitter (Fig. 16) made by Taylor, Short and Mason Limited, employs a cylindrical float and can be fitted either inside the liquid vessel on top of the tank or externally. The indicator is actuated mechanically, and the pneumatic transmitter or controller is actuated through a torque tube transmission. Level-Buoy instruments are supplied for standard ranges of 14 in., 32 in., 60 in. and 120 in. of water with specific gravity limits from approximately 0·2 to 2·0. Any standard instrument is available over a wide range of specific gravities. The operating temperature limits are from + 30 deg. to − 500 deg. F., and the pressure rating is 600 lb. per sq. in. at 750 deg. F. As a controlling instrument, the Level Buoy is used in conjunction with the company's Fulscope pneumatic recording or indicating controller which normally provides proportional or proportional-reset control; the proportional range can be adjusted from on-off control to 300 per cent.

Displacer-type level controllers with electrical transmission may be preferred (safety considerations permitting) where electrical power is more readily available than compressed-air supplies. The intrinsically safe displacer level transmitter by Evershed and Vignoles Limited is designed particularly for application in pressure vessels for liquid-level or interface measurement, with a maximum working pressure of 750 lb. per sq. in. It can be used in conjunction with the Evershed electronic process controller which provides for proportional, proportional reset and/or differential control. Movements of the displacer are used, through a mechanical linkage and a separate electronic power unit, to vary the current in a coil which is connected to the distant indicators or process controller, this current providing a measure of the liquid level.

HEAT-TRANSFER DIFFERENTIAL SWITCH

A new principle of on/off level control and indication for use in tanks, boilers, sterilisers, and industrial vessels, and particularly suited for installations such as pressure vessels, etc., where the interior of the vessel being controlled is not readily accessible for servicing, has recently been introduced, in the form of a thermal liquid-level switch, by Teddington Industrial Equipment Limited, Sunbury-on-Thames, Middlesex, which operates on a difference in heat transfer between the sensitive element and the liquid in the vessel, or the sensitive element and the vapour (British Patent No. 565,309). It does not depend on the temperature difference or on latent heat. Level changes of the order of ½ in. are sufficient to operate the switch. The operating mechanism is temperature-compensated, and the instrument is therefore unaffected by temperature over the range 0 to 380 deg. F. Automatic surge damping is inherent, since a positive change in level of sufficient duration to affect the heat-transfer rate is necessary before the switch will operate.

The new Teddington instrument switch requires no subsidiary amplifier for switching load up to 5 amperes at 250 volts alternating current, and, it is claimed, requires no maintenance.

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LOADING COUNTER

For the purpose of counting the number of sacks loaded on to a lorry per shift, the load per lorry, and the number of burst sacks that occur, Fisons Limited, at their Barking factory, have installed an electronic photocell counter made by the Electronic Machine Company, Limited, 9 Mayday-road, Thornton Heath, Surrey. The 1 cwt. paper sacks are of the valve closure type, and are filled at the rate of 600 per hour, equivalent to 30 tons. There are no checkers or tally men on the lorries—everything is controlled from the filling machines on the first floor, where there are two men only. One of these operates the twin-head filling machine, and the other keeps the first supplied with sacks, removes burst sacks, and switches the guide chute as each lorry load is completed. There are two lorry stations at the loading bank.

The filling machine operator places a sack on the head, operates the hopper valve and allows the sack to be automatically filled with exactly one cwt. There is a vibrator foot on which the sack rests which causes the fertiliser to be shaken down during the filling cycle thus ensuring an even filling. The sack is then allowed to drop on to a conveyor while the operator is working on the next sack.

Bags of fertiliser, filled on a twin-head machine, are counted electrically as they are conveyed to waiting lorries.

The conveyor takes the sack through a "counting tunnel" in which are situated the electronic photocell light heads. The sack passing through breaks a light ray and this causes the "count" to be registered as the sack passes to the chute which takes it to the ground floor and thus to the lorry at the loading bank.

Two remote display counters are fitted and the first registers the lorry load total; the completion of this total is the signal for the second operator to switch the chute guide so that the second waiting lorry can commence loading. The second display counter registers the aggregate for the shift.

STUD WELDING

The process of stud welding was actually first introduced about 1919 in connection with dockyard equipment. After being in abeyance for some years, it came to the fore again during the last war, and since then several types of equipment have been introduced. One of the most recent is the lightweight Cromp-arc set introduced by Crompton Parkinson Limited, Crompton House, Aldwych, London, W.C.2. It is shown in the illustration.

The stud welding gun complete with cable weighs only 5½ lb. but will take studs from ¼ in. to ⅜ in. in diameter. The controller weighs 26 lb.

Capable of handling studs from ¼ in. up to ⅜ in. in diameter, the gun itself, complete with cable, weighs only 5½ lb., and the entire control unit only 26 lb. It is claimed that it can work on a supply from any direct-current source. The gun has a self-adjustment so that studs whose length varies within ± ¼ in. can be accommodated without any change of holder. The length of the leg can be varied to accommodate studs up to 3½ in. long. The single point foot at the bottom of the adjustable leg is interchangeable with the standard feet of the existing "Nelson" stud welding tools, and the new gun can take the complete range of Nelson standard ferrule grips.

The welding action is that, after the stud has been set in position, the button on the pistol grip is pressed, initiating the pilot arc. This arc ionises the gap between the stud and the base for the main welding arc, which comes into operation as soon as the button is released. The timing of the main arc is governed by a pneumatic regulator in the controller.

The equipment has been kept light in weight and low in cost with a particular view to the user who requires only occasional application of the process and to the small concern.

BURSTING DISCS FOR HIGH-PRESSURE HYDRAULIC SYSTEMS

*By A. Urbanski**

In most high-pressure hydraulic circuits it is necessary to safeguard the system against sudden overload. In normal circumstances a conventional relief valve offers sufficient protection, but there is a risk of leakage which in some closed circuits cannot be accepted.

In designing a system of automatic control for mill rolls the need arose for a pressure-relieving device for a closed and sealed hydraulic circuit used on the hydraulic gauge control.[1] Four possibilities were considered: the shear diaphragm,[2, 3] shear plug, plain diaphragm,[3] and shear-pin bursting discs.

The operation of the bursting discs considered, all of which are based on the failure of a diaphragm, a plug or a pin when the pressure on one side of the device exceeds a predetermined figure, depends on three factors: (1) the ratio of working pressure to bursting pressure, which, if it is too great, makes possible a slow yield in the material and an eventual failure at a pressure lower than designed; (2) fluctuations of the working pressure of the plant, which may produce failure due to fatigue; and (3) close uniformity of the material used for the manufacture of the diaphragms, plugs and pins. This is essential for the reproducibility of results.

Satisfactory operation was required with a ratio of working pressure to bursting pressure of the order of 3 to 4, with indefinite fluctuations of pressure within the working pressure.

The shear disc, shown in its typical form in Fig. 1 (*a*) consists of a flat metal plate clamped on the circumference between a pair of sharp-edged steel rings and two thick circular plates bolted together through the middle of the disc to form a stiffening hub.

The pure shear action is difficult to achieve in practice, since a very close fit of the hub plates in the rings would not permit them to slide out freely when failure takes place. The fit of the plates thus introduces a variable which is likely to affect the consistency of results. Yet another disadvantage of the design is the difficulty of preventing leakage through the bolt connection. For these reasons, the shear-diaphragm bursting disc was rejected.

The shear-plug bursting disc was an attempt to reduce the complexities of the shear-diaphragm disc. A hollow Tufnol plug with a circular incision was made (Fig. 1 (*b*)), a weak material being chosen in order to make the plug as thick as possible to avoid bending. After the initial tests it was found that machining to uneconomically close tolerances (despite the thickness of the plug) was necessary to obtain consistency of results. The tests on three similar plugs gave prohibitive scatter, and this line of approach was therefore discontinued.

PLAIN DIAPHRAGM BURSTING DISC

The plain diaphragm disc assembly shown in Fig. 1 (*c*) consists of a thin circular disc clamped on the circumference by a pair of steel rings, with the centre of the plate exposed to pressure.

A number of $\frac{3}{4}$ in. diameter discs cut out of mild steel strip 1 in. wide and 0·004 in. thick were tested under static pressure when clamped between a pair of sharp-edged rings. There was perfect repeatability of bursting pressures. When the discs were loaded with fluctuating pressure, however, bursting generally occurred during the first ten cycles even with maximum pressures not exceeding one quarter of the failing pressure for discs under static load.

Rounding the edges of the clamping rings (Fig. 1 (*d*)) increased the life of discs whose initial static bursting pressure was 4,500 lb. per sq. in. to approximately 1,500 cycles of 0-1,000 lb. per sq. in. after which rupture occurred.

* British Iron and Steel Research Association.

The static tests, however, on two similar assemblies with rounded edges, A and B, produced scatter of ± 13·3 per cent. and ± 12·5 per cent. respectively, as shown in Table I.

The large scatter of bursting pressure values with the modified ring was thought to be due to

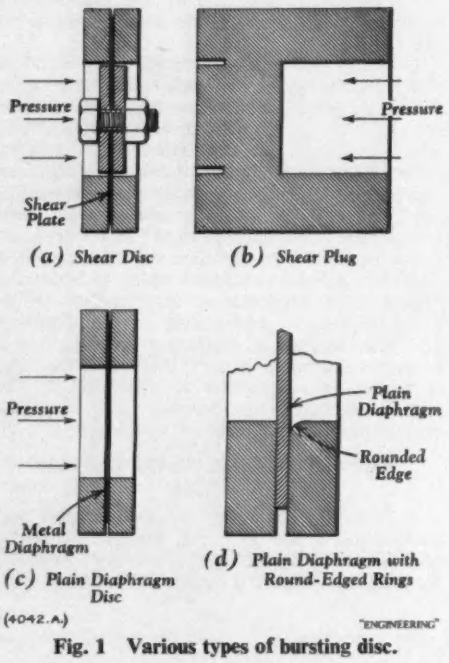


Fig. 1 Various types of bursting disc.

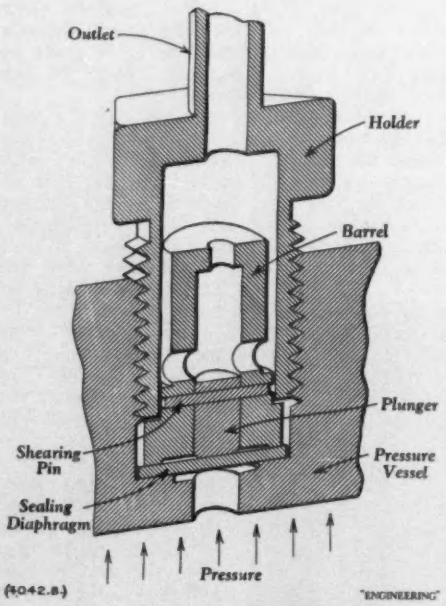


Fig. 2 Shear-pin relief mechanism.

TABLE I *Bursting Pressures on Two Similar Plain Diaphragm Disc Assemblies with Round-Edged Clamping Rings*

Assembly A	Assembly B
5,100 lb. per sq. in.	4 400 lb. per sq. in.
4,500 " "	5,500 " "
4,600 " "	5,300 " "
4,500	4,400 " "
3,900	4,300 " "

the greater influence of small variations in material quality under the less clearly-defined stress pattern. Therefore the percentage scatter of results would be expected to decrease with increased diameter of the diaphragm. If so, increased consistency can be produced with large diaphragm diameters. This, together with the improved life under fluctuating pressure suggests that plain diaphragm discs with round-edged rings should form a reasonable means of protection for systems with low working pressures and low ratios of working to bursting pressures of the discs.

SHEAR-PIN RELIEF MECHANISM

A relief mechanism based on a shear pin and sealed by a rubber diaphragm is illustrated in Fig. 2. The mechanism consists of a barrel in which a sliding plunger is held in position by a push-fit pin with its bottom face slightly proud of the barrel. A Neoprene diaphragm $\frac{1}{8}$ in. thick covers the bottom face of the barrel and plunger, and is clamped down by the foot of the barrel to act as a seal. The thickness of the diaphragm and the close sliding fit of the plunger are such as to prevent extrusion of the rubber under fluid pressure.

The pressure-relieving action takes place when load on the exposed (bottom) face of the plunger causes a shear failure of the pin. The diaphragm, no longer rigidly supported, breaks, and the plunger is pushed by the fluid until stopped by the barrel shoulder. The oil is discharged through four ports into the space around the barrel, and from there to the outlet. The device was designed to burst at 4,400 lb. per sq. in. and the static-pressure tests produced consistent results.

Two assemblies, C and D, with designed static bursting pressures of 4,400 lb. and 4,500 lb. per sq. in respectively, were subjected to fluctuating pressures and their lives were checked at different pressure ranges. The time available did not permit cyclic loading of the pins to failure at the lower stress levels. They were taken out of the testing apparatus after a number of cycles, and burst under static pressure. The results of these tests are shown in Table II.

The barrels and plungers of the two assemblies tested were made of case-hardened mild steel. The pins were of untreated high-carbon steel. It is thought that the life under cyclic stressing could be improved by the use of hardened steel, but owing to the difficulty of ensuring uniform hardness, further development has not yet been pursued in this direction.

In conclusion, it appears that the relief device using a shear pin seems to have a greater consistency and longer life under cyclic loading than that of a plain diaphragm. Further work is, however, necessary to produce a device entirely satisfactory for the automatic gauge control, since the effect of creep has not been investigated; and further work remains to be done to establish the highest ratio of working

TABLE II *Fluctuating Load Tests on Shear-Pin Bursting Disc*

	Pressure range, lb. per sq. in.	Number of pressure cycles completed	Frequency, cycles per min.	Designed static bursting pressure, lb. per sq. in.	Static bursting pressure after cyclic loading, lb. per sq. in.
Assembly C ..	0—4,000	70	70	4,400	Failed during cyclic loading
	0—3,000	5,000	80	4,400	4,400
	0—2,500	5,000	100	4,400	4,400
Assembly D ..	0—4,000	80	70	4,500	Failed during cyclic loading
	0—3,000	5,000	80	4,500	4,300
	0—2,500	5,000	100	4,500	4,500

pressure to maximum pressure with various materials.

REFERENCES

[1] A. Conway, "Design for a System of Automatic Gauge Control by Hydraulic Modulation of Roll Load," unpublished B.I.S.R.A. report.

[2] G. R. Prescott, "Rupture-Disc Design Evaluation and Bursting Tests," *Trans.* A.S.M.E., vol. 75 (1953).

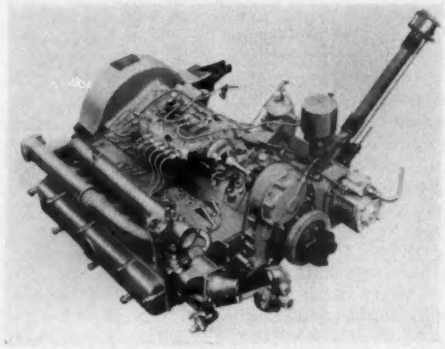
[3] G. F. Lake and N. P. Inglis, "The Design and Manufacture of Bursting Discs," *Proc.* I.Mech.E., vol. 142 (1939).

ECONOMICAL BUS AND COACH CHASSIS

A new bus and coach chassis, which is claimed to offer unusual economy both in first cost and in fuel consumption, has been introduced by Albion Motors Limited, Scotstoun, and is shown in the accompanying illustration. Known as the Aberdonian—to underline its thrifty character—it has an 8 ft. wide chassis with a wheelbase of 16 ft. 4 in. and an overall length of 29 ft. 8 in., suitable for a 30 ft. body. A dropped extension at the rear of the frame can be supplied for coach operation when a large luggage boot is required. The maximum laden weight of the complete vehicle is limited to 8 tons 10 cwt., which is sufficient to allow for a 41-seater bus body or a 35/39-seater coach.

By the use of special steels and light alloys, an extremely low weight—only 57¾ cwt. dry—has been achieved, it is claimed, without in any way sacrificing reliability and capacity to carry its rated load. It is, moreover, marketed at a low initial price, the result of the rationalisation of major units, which in addition to the well-known Albion 5-speed gear-box and rear-axle overhead worm drive with 7 in. centres, includes the Leyland 0·350 Diesel engine. The use of this power unit provides a power-to-weight ratio of 0·56 b.h.p. per cwt. when the vehicle is operating at recommended load capacity. Road tests show a fuel consumption of over 20 m.p.g. under coaching conditions, at an average speed of 30 m.p.h.

The Leyland 0·350 horizontal engine, shown below, with a C.A.V. fuel injection pump and Leyland multi-hole injectors, is a similar unit to the one used in the Leyland Tiger Cub economy-bus chassis, but the engine speed is limited to 2,000 r.p.m., when it develops 94 b.h.p. The maximum torque is 255 lb.-ft. at 1,400 r.p.m. The Aberdonian engine incorporates a centrifugal oil filter which operates on the by-pass principle and has a flow rate sufficiently high to ensure that the entire oil supply is filtered every few minutes. This type of filter dispenses with the use of a replaceable element and can be easily cleaned.



The Aberdonian is powered by a Leyland 0·350 Diesel engine which is able to develop 94 b.h.p. at 2,000 r.p.m.

The engine, clutch and gearbox are three-point mounted by a flexible linkage incorporating Silentbloc bushes at the front; at the rear, brackets at either side of the flywheel housing are pivoted to bell-crank suspension arms, whose lower ends locate in ball mountings on a bracket attached to the frame, whilst their upper ends are anchored through rubber dampers to the frame assembly. This arrangement locates the unit in the frame during acceleration and heavy braking, torque reaction being fully absorbed by the rubber dampers.

A flat-tube cross-flow radiatior is employed, inclined at about 45 deg. so that its large cooling area can be accommodated in a shallow depth. Water at high velocity is forced twice across the radiator to provide highly efficient cooling under wide variations of ambient temperature and conditions of service. The radiator has quickly removable tubes and incorporates a 15 in. diameter close-cowled fan, shaft-driven from the engine crankshaft.

Gear changing, which is effected through a linkage consisting of tubular shafts and universal joints, is said to be particularly pleasant on this machine. The gearbox, which has an aluminium case, well-ribbed for stiffness, has five forward speeeds and one reverse. All forward speeds are running in constant mesh and engaged by dogs. Special care has been taken to ensure that the loose dog clutches on the main shaft receive a supply of oil. Some of the oil thrown up by the gears is trapped and transferred to a central reservoir in the hollow main shaft from where it is fed under centrifugal force through radial holes to the dog clutches. A Holmes Holset type of torsion damper is fitted. Gear ratios are top, direct; fourth, 1·63; third, 2·715; second, 4·36; first, 7·08 to 1. Reverse gear ratio is 6·28 to 1.

A single I-section forging in alloy steel is used for the front axle and is designed to carry the load with a considerable factor of safety. Pivot pins are carried in plain bushes, the thrust being taken on shrouded bronze and steel bearings. This arrangement ensures a free-running bearing which contributes largely to easy steering.

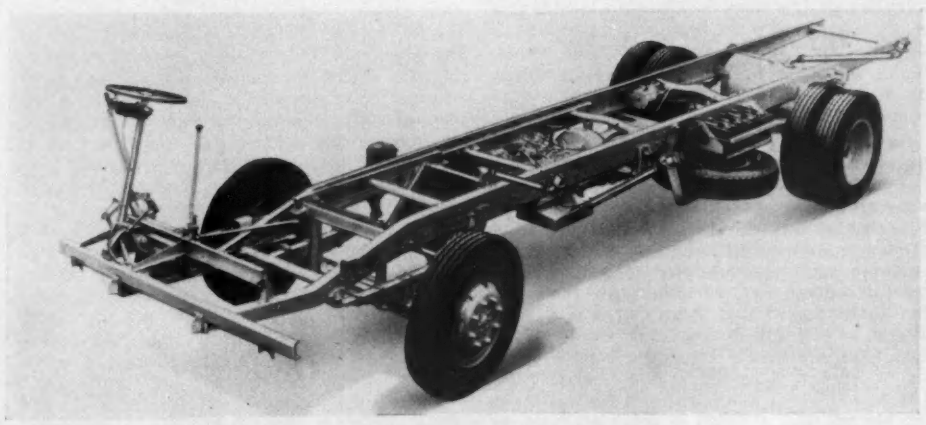
The steering gear is of the Marles cam-and-double-roller type, rigidly mounted on an outrigger extension at the front of the chassis. Steering is arranged so that the ball pin on the steering arm is in front of the axle and the steering connecting rod runs back to the ball pin on the stub arm. This layout prevents road shocks from being transmitted to the steering wheel and cuts down wear and tear on all parts of the steering gear. The turning circle is approximately 61 ft.

Two alternative rear-axle ratios are available, 5·2 to 1 and 5·6 to 1. The unit is of the fully-floating type with an overhead worm drive with 7 in. centres. The axle shafts transmit torque only, the load being carried by the axle body which is a one-piece forging of special alloy steel. The worm assembly, with differential, can be withdrawn without disturbing the road wheels. Heavy-duty taper roller bearings carry differentials, worm shaft and hubs.

Powerful brakes with a total effective braking area of 451 sq. in. operate on moulded liners. The brakes are of the two-leading-shoe design and are actuated hydraulically with vacuum-servo assistance. Vacuum is created by an engine-driven rotary exhauster which feeds a large reservoir tank mounted on the inside of the nearside frame member just forward of the rear axle. A vacuum gauge is included in the instrument panel. The brake drums can be detached without disturbing the hubs. Semi-elliptic springs are used for both axles.

The Aberdonian's frame side members are a pressed channel section 8¾ in. deep by ¼ in. thick with 2½ in. flanges. It is braced with tubular and pressed steel cross-members bolted in position. A 34-gallon fuel tank is suspended from brackets between the frame members immediately behind the rear axle.

The switch box for the 24-volt lighting system is supplied loose for mounting on the front-dash of the body, the control board being carried on the nearside frame member adjacent to the battery cradle which is mounted on the outside of the frame member just forward of the rear wheels and directly above the spare wheel which is carried in a horizontal position. The dynamo, driven by twin belts from the fan shaft-drive, has a useful output of 480 watts. An illuminated instrument panel with oil pressure gauge, vacuum gauge, fuel meter, speedometer and combined horn push and dipper switch, is well positioned on the steering column in view of the driver.



The ightweight Aberdonian chassis weighs 57¾ cwt. dry and provides for a maximum laden weight of 8 tons 10 cwt.—sufficient for a 41-seat bus.

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USED MACHINES

There is a very considerable market in industry for good secondhand machinery. Much of this is put on the market merely because it has been replaced by a different equipment to suit other tooling arrangements rather than because the machine itself is out of date or faulty.

Newall Group Sales Limited have set up new premises at Oundle Road, Peterborough, for the sole purpose of handling this trade. Secondhand machines are taken there, restored to their original condition, and offered again for sale. Each machine is completely rebuilt, and special processes have been installed for cleaning castings and the like.

The reconditioned machines have to pass the metrology department of the Newall Engineering Company, Limited, or, alternatively, must reach the standards which have been laid down by the Institution of Production Engineers or Dr. Schlesinger.

One field in which the company are dealing is the conversion or modification of standard machines to meet special requirements. An example is the conversion of a cylindrical grinder to a special-purpose production machine for making rock drill bits.

The premises have a main factory area of 10,000 sq. ft., not including outbuildings.

Book Reviews

UNSTEADY RADIO MIRROR

Worldwide Occurrence of Sporadic *E*. By E. K. SMITH. *National Bureau of Standards Circular* 582. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (3·25 dols.)

The ionosphere, which is responsible for the reflection of upgoing radio waves and their reception at a distant point, is continually varying. Most of these variations are regular and predictable; indeed, predictions based upon past experience are used with considerable success in deciding the best frequency to be employed for a particular route at a particular time in the future. But some events occur in a less regular way. One of these, the occurrence of sporadic E reflections, is the subject of a comprehensive study in this book.

Dr. Smith defines sporadic E propagation as "A comparatively strong and protracted transmission (several minutes to several hours) returned from the E region of the ionosphere by some mechanism other than the normal reflection process from the daytime regular E layer." This definition, although it excludes "forward scatter" and transitory echoes from meteor trails, includes several different types of reflection.

These different types, however, all have the same practical effect. Since they are irregular, in both time and space, they are not usable in normal commercial communications and broadcasting (although they are often used by amateurs); but their presence often causes interference, especially in the lower V.H.F. band (30 to 70 Mc/s). It is important, therefore, that the properties of sporadic E be well known, so that services in this band can be planned with due regard for the likely level of interference.

Dr. Smith divides the world into zones according to the temporal behaviour of sporadic E in each. In the auroral zone (aurora present for longer than 15 per cent. of the time), sporadic E occurs mainly at night throughout the year. In the temperate zone (nearly all the rest of the world), it occurs mainly in summer and mainly during the day. In the equatorial zone (magnetic dip less than 10 deg.), it occurs as in the temperate zone, but with the addition of a special type of sporadic E during the daytime.

The most comprehensive data in the book are a series of maps which give, for all positions in the temperate and north auroral zones, the percentage of time during which the sporadic E critical frequency exceeds 5 Mc/s; separate maps are given for day and night, and for summer, equinoxes and winter. Additional "maps" give more detailed temporal variations at a series of selected stations. All these results were obtained from vertical-incidence ionosphere sounding stations. As Dr. Smith points out, it is difficult to attach a definite meaning to the "critical frequency" of sporadic E as found by this method, since the observed critical frequency depends on the parameters of the observing station. However, the fact that results from many stations agree indicates that these results are significant. The meaning of the results for practical purposes can be gauged to some extent from the chapter concerned with monitored field strength on V.H.F. links, and reports of interference to television reception.

Dr. Smith finds that sporadic E is correlated with day to day magnetic activity, positively in the auroral zone, and negatively in the temperate zone, but there is no correlation with the sunspot cycle.

A very interesting conclusion, supported by both vertical incidence and oblique incidence data, is that sporadic E is much more prevalent in Japan than in the United States. The vertical incidence data suggests that this is so for S.E. Asia generally. The information suggests that it would be unwise to allocate any frequency in the band 30 to 70 Mc/s for use in S.E. Asia for broadcasting or ionospheric forward scatter, and to consider carefully before allocating any such frequency for other uses.

The book contains a discussion of the frequency variation of sporadic E, the possible origins of sporadic E, an account of the methods used in scaling ionospheric records, and some geomagnetic information. Altogether the book would be extremely useful to anyone concerned with the propagation of radio waves in the lower V.H.F. band, or with happenings in the E region of the ionosphere.

There are about a hundred illustrations and about a hundred references. Unfortunately the latter are incomplete, at least seven references in the main text being absent from the list at the end of the book.

MEASUREMENT AND CONTROL

Messen und Regeln in der Chemischen Technik. By J. HENGSTENBERG, B. STURM and O. WINKLER. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (146 *D.M.*)

This book is a superb encyclopaedia on measurement and control, primarily in the chemical industry, but a reviewer would be less than honest if he were to pretend that its real worth could be assessed until he had used it as a reference book for many months. All that he can properly do is to give some indication of its scope and calibre, and to suggest that anyone interested in process control, whether from the chemical, mechanical or electrical aspects, must at least look through it carefully before deciding that he does not need it in the library which he uses; at £11, individuals may hesitate to buy it.

The book has been written by some 31 different authors, most of them physicists and chemists engaged in the chemical industry—and deliberately written from the standpoint of the industrial user. While some attention is paid to the design of instruments, this is nowhere dealt with from the designer's point of view, a fact which is recognised in the preface, where the book's origins and aims are fully discussed. The work has been fathered by NAMUR (the German standardisation association for measurement and control technology in the chemical industry) which was perturbed by the fact that the possibilities for technical education in its field of interest have hitherto been very limited in Germany. In particular, it was concerned at the lack of any comprehensive books on the subject which would enable the beginner in this field to obtain a sound introduction to it. In point of fact, this work is exhaustive, and it may be doubted whether the beginner will be able to see the "wood for the trees"; but the mathematics used have deliberately been kept simple, and at a level which will not frighten any science or engineering graduate.

An attempt has been made by the editors to introduce some uniformity of presentation and to avoid overlapping, but inevitably they have not been entirely successful. It is interesting to find that almost all the authors show some familiarity with both the English and American literature, and refer to it more frequently than is usual in modern German technical works. It is less surprising to find American and English designs of controllers discussed, since, in this field, Germany is well behind the English-speaking world, and is having to import extensively. The anxiety felt at this situation is exemplified by the big selling-fair which is being arranged by the German instrument industry for this autumn.

Some idea of the balance of material in the book may be obtained from the number of pages devoted to different topics. The first 840 are given over to the theory and practice of the measurement of a very wide range of physical and chemical properties of materials, both continuous and discontinuous methods being considered. The next 320 pages are used to discuss the theory and practice of automatic and remote control, with details of present-day practice. The final 80 pages discuss the problems of factory organisation of control, and the proper evaluation of results. The weakest section appears to be that on the theory of control, where too much has been included and the essential principles are difficult to find.

The volume constitutes another worthy addition to the Springer catalogue.

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LININGS FOR FURNACES

Steelplant Refractories: Testing, Research and Development. By J. H. CHESTERS. *The Publications Department, The United Steel Companies, Limited,* 17 *Westbourne-road, Sheffield,* 10. (80*s.*)

This work, now in its second edition and revised and completely re-written, is of such universal importance that it cannot be dismissed as just another text-book for the novice, nor as an adornment for the book-case of the office library. The information available on every one of its 728 pages offers not only data presented in a simple and readily assimilated manner, but also a wealth of detail amounting to experience, which no one engineer or chemist could hope to gain in a lifetime of practical observation. Thus, we have a text-book which, if applied intelligently, can provide most of the answers to present refractory problems arising in the every-day operation of modern furnaces.

The question, "What is the use of a laboratory test sheet for a given refractory?" is often asked, particularly after a failure has been brought to light by a short service run. Under the faster working conditions prevailing to-day in most steel plants, refractory failure is more noticeable by the frequency of repair, with the consequent raising of the pounds per ton of steel made ratio becoming increasingly evident. In order to offset this increase in refractory expenditure, the operator must be guided as much by scientifically collated data, as by physical inspection and his own experience. He must collate the known conditions of a particular zone with the analysis of the material in service in that zone.

The aim of steelplant production management, is to teem as many ingot-tons in as short a time as possible under quality-control conditions, and it is the refractory superintendent's task to maintain the plant in such condition that production periods are interrupted as infrequently as possible. To achieve this, he must assess each cause of failure on its own merits, both by visual and chemical means. One could give many precise details of failure experienced, but as these are not only encountered by everyone engaged in steel production, but are also amply catered for in the volume under review in the various paragraphs dealing with the properties, methods of manufacture and technical data in the form of analysis, for each type of refractory, they would be superfluous. Analysis constitutes a keynote of the characteristics of refractories, although, as Dr. Chesters points out, bricks of a similar chemical analysis, may not always give a similar performance, being derivatives of different integrants or, using the expression loosely, "synthetics." Therefore, in assessing failure and adjusting the performance of refractories, the analysis data give an extra guide by classifying the material as "typical" or "composite."

Dr. Chesters guides our steps in a firm but pleasant manner into an exposition of the reasons for the analysis, a step-by-step method of analysis of not only the integrants of refractories, but of

their potentials in service. He then goes on to the many instruments and machines employed in this service and their functions, and gives an appreciation of the various materials met with in every steel plant daily, their geographical origin, chemical differences and inter-reactions, and their methods of manufacture and service application.

In Chapter III, the short history of the extraction of magnesite from sea water forms an interesting prelude to a very thorough treatise on magnesite in its many forms and, with the same easy grace and meticulous care, on through the remainder of the basic materials, and ending this section of the book with a very thorough exposition on two of the most widely used, abused and misunderstood friends of bricklayer and engineer alike—the alumino-silicates and insulation materials.

A typical " Chesters' touch " catches the eye at the beginning of Chapter VII on " Insulation." Here he quotes Oliver Lyle's parody on Hiawatha; this is an example of Dr. Chesters' flair for the simple, easily absorbed explanation of a complex subject. While these few lines of verse may or may not give the reader moments of amusement, they do claim his attention and condition the mind to the more serious subjects of study which, though written in easy vein, are meticulous and exhaustive.

From Chapter VIII onwards, the author deals exclusively with furnaces of all descriptions, and gives many hints to the design engineer, as to how the performance of not only a furnace as a whole, but of its various zones, may be profitably increased. In this connection, he discusses the conditions pertaining within the furnace and gives recommendations of the types of refractories to be used, and deals also with certain fundamental design techniques brought up to date by modern research development. Comparisons are made of the merits between the basic and the acid open-hearth, between the open-hearth and the Bessemer, between the electric-arc and the induction melting furnaces. Their types, histories, output rates, limitations, types of steel made, and potentials are discussed, and the numerous drawings, photographs, charts and tables included explain and give weight to the findings and recommendations. At no time does Dr. Chesters dogmatise, rather does he give facts and figures in such a way as to cause the reader to relate the subject matter to the conditions with which he is personally associated, and at all times to think for himself.

Much useful information is given in the appendices, beginning with a short dictionary of steelworks chemical and engineering nomenclature, and ending with a brief and concise chapter on the British standard methods of testing refractory materials.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

History of Pipe Making. *Fifty Years in Derby.* AITON & CO. LTD., Derby. The firm of Aiton was only seven years old when it found its original works at Willesden too small. The story of the move to Derby, where there was room for expansion, in 1907, and the subsequent development of the works there is told in this illustrated leaflet.

Sequence Timer. ELECTRICAL REMOTE CONTROL CO. LTD., South-road, Templefields, Harlow New Town, Essex. Heavy-duty sequence timer with up to eight independent circuits; timing range from 6 sec. to one month. Capacity 15 amps. (non-inductive) A.C. at 230 volts. Leaflet.

Dynamic Balancing Machines. C. F. R. GIESLER, LTD., River-place, Essex-road, Islington, London, N.1. A new range of dynamic balancing machines, in three sizes, covering component weights from 4 lb. to 2,000 lb. Illustrated leaflet.

Electric Motors. BROOK MOTORS LTD., Huddersfield. *About Ourselves*, describes the growth of the firm and the methods of manufacture now employed there.

On the Shelf

By Frank H. Smith

The Tower of Babel provided one of the major obstacles to the easy dissemination of technical information. Modern times have contributed refinements, such as trade and military security, but the translation business has the added difficulty that it has to find a man (or woman) possessing the combined ability of " bi-lingualism " and technical vocabulary.

For some time, there have been various bodies (notably Aslib and the D.S.I.R.) which have prepared indexes of translations and now iron and steel technicians, comprising the British Iron and Steel Research Association, the Iron and Steel Institute, etc., have decided to compile their own. This will not be confined, in its availability, to the industry, although the industry will be probably the biggest contributor to the index. The translations will be available at a given charge (with reductions for quantity) to anyone interested. A further announcement will be made when all the arrangements are complete.

I have been gently taken to task (this is always happening to me) for describing *Impulse* as a house magazine on page 51 of ENGINEERING for July 12. It is a " sponsored " publication, I am told. One must be careful in one's choice of adjectives and I must thus add another to that group covering material issued under the name of a specific firm not normally connected with publishing. Hitherto I have lumped them together as house magazines of either the gossip or the prestige type.

Considering its importance, the International Congress of Applied Mechanics is one of the most difficult organisations from the point of view of tracking down its *Proceedings*. Each congress is held in a different country and, instead of the publications being issued by a central body, each organising country has a responsible publishing house. There has even been an occasion when no *Proceedings* were available. I have just received the first volume of the ninth congress and it is published (1957) by the University, 50 Avenue Franklin Roosevelt, Brussels, Belgium.

British Rates and Data, 132-4 Fleet-street, London, E.C.4, Volume 2, dealing with the trade technical and professional periodicals, gives particulars of interest to prospective advertisers. Such details as circulation figures, publishing dates and rates for advertisements are given. Newspapers, television and consumer magazines are covered by Volume 1. The subscription rate is £2 2*s.* per annum, covering one copy of each volume every other month (12 volumes a year).

Aviation Age Research and Development Technical Handbook sounds like the answer to 90 per cent. of the aeronautical librarian's queries. Actually, it is a quite massive catalogue of aeronautical products with two or three pages of editorial matter introducing each of twelve sections. In addition, the products are conveniently tabulated to show their main features.

I seem to remember that some years ago there was an idea prevalent that only technical books were allowed to be published in the Soviet Union. No. 369 of the *Soviet News* contains, in an article entitled " In Defence of the Reader," some interesting figures to prove that this is no longer the case. In 1955 Conan Doyle's *The Hound of the Baskervilles* was published in an edition of 525,000 copies by the State Publishing House. The next year, Vladimir Book Publishers issued an edition of 100,000 copies and the Children's Publishing House one of 300,000 copies. Presumably these are all sold. Mayne Reid's *The Headless Horseman* ran to 1,125,000 copies and Dumas' *Count of Monte Cristo*, *Queen Margot* and *The Three Musketeers* totalled 2,615,000 copies in 1955-56 ! Other figures in the same article are quite fantastic and one wonders if there are comparable sales for text-books. If there are, it might be worthwhile considering a reversal of the present fashion for the translation of Russian technical matter into English.

The Aircraft Industries Association of America produces an annual *Aviation Facts and Figures*. This is a review of the year with comparisons, where convenient, with previous years of the various aspects of the industry. Such chapter headings as finance, airlines and transportation, manpower and guided missiles, give an indication of the book's scope and, as well as the reviews, there are tables of figures and useful statistics. An unusual feature is a list of public relations officials of member companies of the Association, with their addresses. Public relations officers are very useful gentlemen to know. An essential of their nature is to be pleasant and if you are one who is given to making inquiries it is nice to know that your inquiry will be pleasantly received. The book's price is 1 dollar.

In the middle of April there was a short correspondence in this journal on the difficulty of keeping abreast of the mass of literature that appears in these technical days. The *Monthly Bulletin* on Scientific Documentation and Terminology of UNESCO for July 15 calls attention to another aspect of the problem. It seems that an international congress contemplated by the Fédération Européenne de la Corrosion has been abandoned, as not enough delegates from other countries would be able to participate. This poses the question of whether " congressitis " has now become acute and, if so, what should be done about it? The real value of a congress lies in the contacts made, but are those contacts worth airline journeys plus the pound-man-hours expended on week-long paper-feasts? The editor of the *Monthly Bulletin* (at the Department of Natural Sciences, Unesco, 19 Avenue Kléber, Paris 16e) will welcome correspondence on this subject of congresses. The issue for July 15 also contains a résumé of J. Farradane's letter which appeared, on the subject of information work, on page 709 of ENGINEERING for June 7.

When one investigates the history of any branch of engineering it is always useful and interesting to know who was the first in the field. Take powered flight for instance. It is generally acknowledged that the Wright Brothers were the first to accomplish powered controlled flight, but there are still people who put forward claims for Ader, Whitehead and others. It is when arguments on the claims arise that it is useful to have an item such as appears in the latest copy of the *Ryan Reporter* (volume 18, No. 2, issued by the Ryan Aeronautical Company, Lindbergh Field, San Diego 12, California, U.S.A.), with the title " Chronology of World-Wide VTOL Development." Ryan's achievements are, naturally, given prominence but I think the list is free from undue bias. Their " test rig " first lifted itself off the ground on October 20, 1950, and, on May 31, in the following year, they claim " Ryan test vehicle makes world's first free hovering jet flight." The Rolls-Royce " Flying Bedstead " did not make its first tethered flight (according to the *Ryan Reporter*) until August, 1953.

Mobile Crane. BROWN AND TAWSE PLANT, LTD., Ambrose-street, West Gorton, Manchester, 12. Hydraulically-operated crane mounted on a four-wheel drive lorry chassis. Lifting capacity up to 45 cwt. at 17 ft. 3 in. Illustrated leaflet.

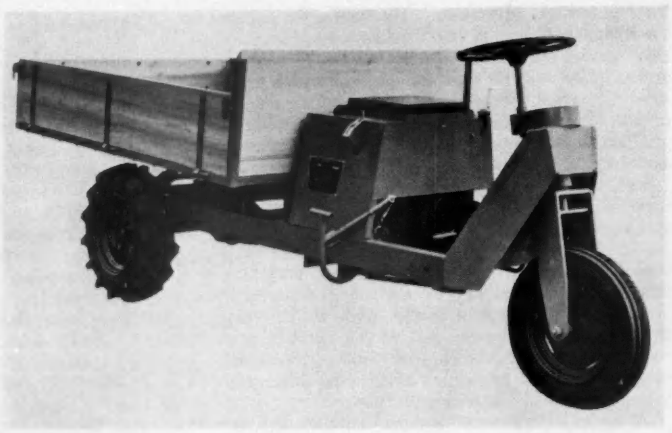
Anti-vibration Mountings. DUNLOP RUBBER CO. LTD., Engineering Components Division, Fort Dunlop, Birmingham, 24. Studded and ribbed " carpet-type " anti-vibration mountings for heavy machinery. Illustrated technical descriptive leaflet.

Locomotive Builders. THE VULCAN FOUNDRY LTD., Newton-le-Willows, Lancashire. " Built by Stephenson " booklet giving the history of two famous locomotive builders.

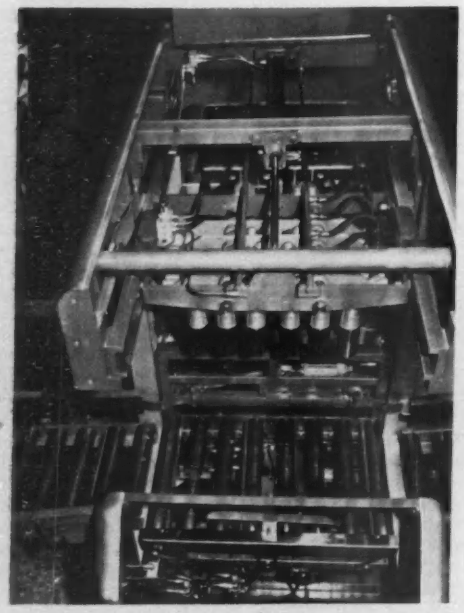
GENERAL PURPOSE TRUCK

A three-wheel petrol-driven truck for industrial uses as well as for the farm, market garden or smallholding, has been introduced by Frank Bonser and Company, Limited, Hucknall, Nottinghamshire. As may be seen from the illustration, it is driven by the two rear wheels, which are fitted with a differential gear, and is steered by the single front wheel. The driver's seat is immediately over the engine. The arrangement is designed for good traction on soft ground.

The engine is approximately 5–6 h.p. working on the four-stroke cycle, and drives through a three-speed and reverse gearbox. Top speed of the truck is approximately 12 m.p.h. Transmission is through a multi-plate clutch to the differential on the rear axle, and Girling mechanical brakes are fitted. The steering is geared for ease of operation. The body has a capacity of 1 ton, and is arranged for manual tipping. It measures 5 ft. 6 in. long by 4 ft. wide by 1 ft. deep. As an alternative to the petrol engine, one which runs on vapourising oil can be fitted to the truck.



For general use, this truck has a tipping body mounted over the driving wheels.



Half-pint bottles arriving on a single line conveyor being assembled in batches of 24 and loaded automatically into crates.

CRATING BOTTLES

Where very large numbers of bottles have to be handled, machines have been introduced to insert them into crates of a dozen or so. A machine that will handle 600 dozen half-pint bottles every hour, has been produced by Hambling Industries Limited, Chichester. It is shown in the illustration.

A single line conveyor feeds the machine with standard half-pint brewery bottles, and they are packed into crates which will take 24. Bottles arrive at the machine on the conveyor belt after passing an electronic counter which admits six bottles only at a time. The six are pushed forward by a marshalling bar, and enter the six lanes on the table. As the bar is withdrawn, the next six are admitted, until all 24 are spaced on the assembly table. The latter is then elevated and the bottles gripped by the conveyor head which transfers them to an empty crate that has been brought to the other end of the machine by a roller conveyor. The crate is raised until the bottles touch the bottom, and they are then released. In this way they enter the crate without jar. The elevator then lowers the crate and returns it on to the original line of the roller conveyor, and the transfer gripper head returns to the marshalling table to pick up the next batch of bottles.

The gripper heads are designed to hold the necks of the bottles without damage to the glass, labels or crown corks. The tension of the rubber grips is controlled by air pressure regulators. A separate pneumatic circuit supplies the gripper unit, so that if the packer is stopped through a shortage of bottles or crates, the gripper head remains unaffected and the bottles are safely retained.

The crate centralisation is carried out automatically by fingers on the machine, and variations of up to 2 in. in crate size are allowed for. Crate elevation can also be controlled accurately to suit the heights of the bottles. The interlocks ensure that the gripper head waits until the full batch of 24 bottles arrives before lifting them and, similarly, awaits the arrival of a crate before releasing them. Should the crate be malformed or incorrectly placed, and is elevated to receive the bottles, the gripper head release mechanism is arrested before the bottles reach the lower part of the rising crate. The crate elevator then moves downwards, and the faulty crate is moved on to the despatch conveyor in the normal way.

The machine operates entirely from a compressed air supply, at a pressure of 90 lb. per sq. in. The consumption is 18 cub. ft. per minute of free air. The maximum speed of operation that can be obtained is 750 dozen bottles per hour, although, as mentioned earlier, the normal running is for 600 dozen. The machine measures 7 ft. 3 in. long, 5 ft. wide and 5 ft. 3 in. in height.

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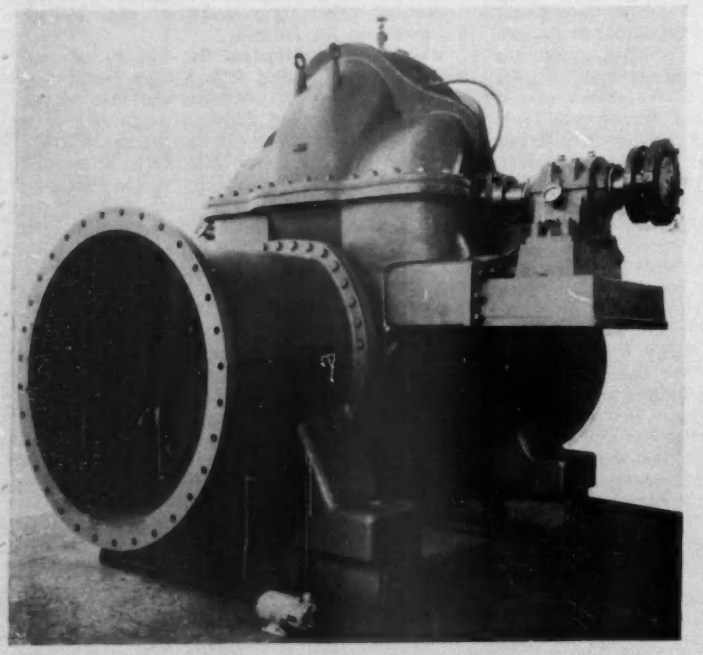
TWO-WHEEL TRAILER

The most recent addition to the Ford-Ransome range of implements is a three ton, two-wheel trailer, which is available as a hydraulic tipping model, using the tractor hydraulic system, or as a non-tipping model. Both are similar in design and are convertible from one to the other. The trailer is designed for use with tractors equipped with an automatic pick-up hitch, but there is also a screw-jack available to facilitate hitching when used with tractors without that attachment. The trailer has an all-steel channelled chassis, and a body 10 ft. by 6 ft. of hardwood, tongued and grooved with steel support members, and has a loading height of 33 in. The body is said to be completely "grain-tight." Hay ladders and extended sides are available.



The largest and smallest Worthington-Simpson pumps have capacities respectively of 75,000 gallons per minute against a 60 ft. head, and 6 gallons per minute against a 40 ft. head.

TWO PUMPING LIMITS

Shown in the accompanying illustration are the largest and the smallest pumps yet made by Worthington-Simpson Limited, Newark-on-Trent. The smallest pump (in the foreground) is one of their standard "Domestic" Monobloc self-priming pumps, driven by a ½ h.p. squirrel-cage motor, capable of priming up to 28 ft. suction lift and with an output of 385 gallons per hour against a total head of 40 ft., and 230 gallons per hour at 120 ft. head.

The large centrifugal pump is one of ten on order for the Central Electricity Authority's Castle Donington power station. Six pumps are already installed. Two sizes of pump are in use at Castle Donington—the larger, shown here, delivering 75,000 gallons of water per minute, against a 60 ft. head, from the condensers up to the cooling towers, from whence the water flows back to the cooling ponds. Each pump is driven by a 1,710 h.p. 420 r.p.m. motor. For pumping river water to the condensers the pumps are of 70,000 gallon per minute capacity, against a 38 ft. head. Each of these pumps is driven by a 1,030 h.p. motor at 367 r.p.m. The cast-iron casing of each pump weighs 15 tons, and the total installation weight per pump is about twice this.

HIGH-PRESSURE INDUSTRIAL HYDRAULIC PUMP

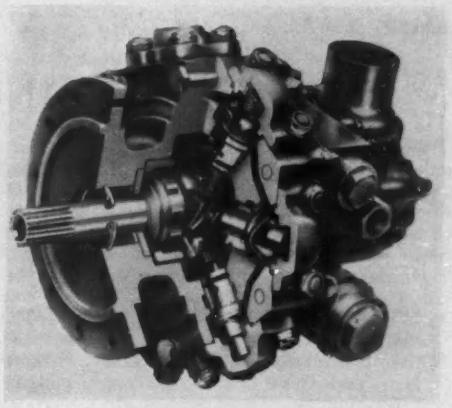
A heavy-duty hydraulic pump for high-pressure systems, suitable for stationary, mobile, and marine applications, has been introduced by Dowty Equipment Limited, Cheltenham. This new industrial version of the Dowty Vardel hydraulic pump is a two-stage self-regulating unit based on a design proved by many years service in the aircraft field. Available for pressures of 1,000-4,000 lb. per sq. in., outputs of 2½-5 gallons per minute and speeds of 1,500-3,000 r.p.m., the pump incorporates its own cut-out and relief valves, delivery ceasing automatically when the set pressure is reached.

An outstanding feature of the Vardel is its low power absorption, reduced to a minimum during off-load periods. At 3,000 r.p.m. off-load, a pressure of 4,000 lb. per sq. in. is maintained with a power input of under 2 h.p. The type of control incorporated in the pump, it is claimed, virtually eliminates "flick" pressures caused by a sudden cessation of delivery when an actuator comes to the end of its stroke. All rotating parts are balanced to eliminate mechanical vibration; all wearing parts are interchangeable and readily replaceable.

The Vardel pump consists basically of a first-stage low-pressure gear pump, a second-stage piston pump and an unloader gear. The first-stage pump draws fluid from the reservoir and delivers it under pressure to the second-stage pump. The capacity of the latter is less than that of the gear pump and the surplus fluid is by-passed through a relief valve set to maintain the required low pressure. A limited quantity is also returned to the reservoir, so dissipating any heat generated.

High-pressure fluid delivered from the second-stage pump to the high-pressure outlet acts also upon the underside of an actuating piston which controls the unloader gear. In the "off-load" condition, the low-pressure supply to the second stage is cut off by the unloading valve except for a small flow through a restricted passage. This flow maintains full pressure in the system during the idling period, any surplus being returned to the reservoir.

While deprived of fluid, the second-stage pump creates a depression on the underside of a compensator piston, which moves so as to permit increased flow through the relief valve, so reducing the power input required. This, in conjunction with the starvation of the second stage, results in the whole pump running with the minimum expenditure of energy while in the idling condition.



The two-stage self-regulating Vardel industrial pump is available for pressures of 1,000-4,000 lb. per sq. in., outputs of 2½-5 gallons per minute, and speeds of 1,500-3,000 r.p.m.

Open-hearth furnaces can be dismantled while still hot, first by pulling down the bricks with a hook and then collecting them in the bucket attachment.

FURNACE DISMANTLING

For the dismantling of the open-hearth furnaces at the Rotherham works of Steel, Peech and Tozer, an American machine, the Gradall, has been installed. Its general characteristics can be seen from the illustration.

It is mounted on crawler tracks and is equipped with a telescopic boom, at the end of which either a bucket or a hook can be fitted. The hook is first employed to claw away the old bricks, and then the three-quarter cubic yard bucket scrapes the debris out of the furnace bath. Dismantling can be begun within five to six hours of tapping a furnace, whereas previously it had to be left 24 hours to cool down before men could enter it. Whereas only 12 of the fourteen 100 ton open-hearth furnaces at the Templeborough melting shop have been in use at one time until now, because of the speedier dismantling it will be possible to maintain 13 in operation.

The machine weighs 13 tons and is driven by a 75 h.p. Diesel engine with hydraulic operation of both the crawler mechanism and the telescopic boom.

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INTERNATIONAL INSTITUTE OF WELDING

Founded in 1948 on the initiative of the national welding institutes and societies of Austria, Belgium, Denmark, France, Italy, the Netherlands, Norway, South Africa, Spain, Sweden, Switzerland, the United Kingdom and the United States, the International Institute of Welding now has member societies in 27 countries. The 1957 annual assembly of the Institute was held in Essen, Germany, from June 30 until July 6; it was attended by nearly 800 delegates and their wives from 21 countries. Broadly speaking, the work of the Institute is carried out through the agency of 15 commissions which study clearly-defined subjects comprising gas welding, arc welding, resistance welding, documentation, the testing and control of welds, terminology, standardisation, hygiene and safety, the behaviour of metals subjected to welding, residual stresses and stress relieving, pressure vessels and boilers and also pipelines, special arc-welding processes, fatigue testing, welding instruction, and the fundamentals of design and fabrication for welding.

At a meeting held on July 31, under the auspices of the Institute of Welding, 54 Princes-gate, Exhibition-road, London, S.W.7, British representatives on each of the 15 commissions gave a brief report on the work accomplished by their commissions at the Essen meeting. The subjects upon which work was done at the annual assembly included filler metals for surfacing, the hydrogen content in weld metal, the testing and inspection of spot welds, recommended practices for flash welding with pre-heating, recommended practices for the radiographic inspection of fusion-welded joints on steel plates up to 2 in. thick, a reference block for ultrasonic inspection, magnetic-particle methods of inspecting welds, standardisation (including arc-welding equipment, resistance-welding equipment and filler metals and electrodes), an acceptance method of testing weldable steels using the V-notch Charpy test, the slow notch bend test, welding cracks in the heat-affected zone of air-hardenable alloy steel, brittle fracture, the stress relief of alloy steels, and edge preparation for fusion welding.

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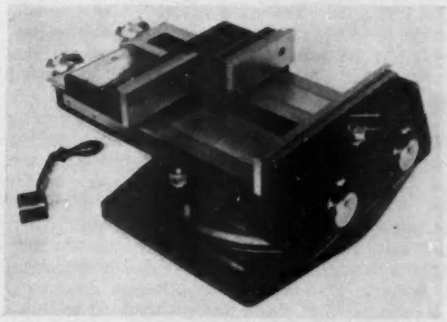
POWER TRANSFORMERS IN SOUTHERN RHODESIA

The British Thomson-Houston Company, Limited, Rugby, have supplied and installed two 20/30 MVA transformers at the Umtali substation of the Electricity Supply Commission in Southern Rhodesia. The transformers are believed to be the largest in Southern Rhodesia and will be used for transforming power from the new Revue hydro-electric scheme in Portuguese East Africa for use in the Eastern Districts —generally known as the Switzerland of Rhodesia—which are not covered by the new Kariba dam project.

The units are fitted with on-load tap-changing gear with automatic control. Alternatively, arrangements can be made for supervisory control from the Umtali power station. The transformers will step down the voltage from 110 kV to 11 kV and are suitable for supplying an output of 33 kV when the system is changed to that voltage.

TWIN-JAW VICE

An addition to the range of "Hylo" vices, for which Alfred Herbert, Limited, P.O. Box No. 30, Edgwick Works, Coventry, are the agents, has twin sliding jaws, each actuated by the Hylo automatic two-speed mechanism. This moves the jaw ½ in. per revolution of the handle until contact is made with the work, when the rate is slowed down automatically to 0·1 in. per revolution. A quarter turn of the handle then locks the vice on the work. The two sliding jaws are each 6 in. wide, and the maximum opening is 12⅛ in. A swivel baseplate, graduated to 360 deg. is provided. Both lead screws are covered by removable filler plates in progressive lengths; the complete mechanism is thus enclosed.



A fixed 12 in. jaw and two 6 in. sliding jaws enable odd-shaped work-pieces, or two separate ones, to be held in the "Hylo" vice.

Marketing

"MUCH BINDING" IN THE U.S.

The case of a British firm who quoted £2 10*s.* 6*d. ex works* at " Much Binding " was printed in the July issue of *The British Manufacturer*, the journal of the N.U.M. They suggest that it is better to quote in United States dollars c.i.f. United States port and, when f.o.b. quotations are used, reference should be made to something larger than " a small village not even mentioned in the A.A. book."

The occasion of this tale is a reminder that British consulates employ marketing officers in New York, New Orleans, Boston, Cleveland and Washington. These officers can undertake market research on behalf of British firms and are in a position to give details of successful assignments " which had resulted in large orders." They also assist in finding reliable agents, and generally in obtaining market information. This is a good source of facts and opinions for a preliminary view. Allied to a search of the immense library of information available in London, it can provide most useful guidance on how to tackle a market where, according to the N.U.M., " thoughtful approach and careful research can pay good dividends."

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Latin American Warning

We are told that " to-day, Britain is unduly regarded in South America as being decadent," by no less an authority than the British and Latin American Chamber of Commerce. This is due, they say, " to our failure to make ourselves known to this huge transatlantic public."

Some of the facts and figures the Chamber published suggest that a vast market is opening up in Latin America. Population trends indicate that the present 175 million will increase to 250 million in 20 years' time and 500 million by the end of the century. But rapid industrialisation, rather than the growth in numbers, is our opportunity. Total imports of Latin American countries are now some five times the pre-war volume, but the British share has declined from 13 per cent. in 1932 to 5 per cent. in 1956.

The Chamber's services are available to those who are interested in a market—or rather some 20 markets—where " there is more to attract than repel, and the difficulties are certainly more apparent than real." The solution to currency difficulties may be some distance away but there will doubtless be more reward for the enterprising, even if it is United States rather than United Kingdom capital which is being pumped into the area at an ever increasing rate.

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High Tasks of 1958

As the summer wears on, and holiday makers return to face the next twelve months, the problems begin to take shape and to intrude on our thoughts. Towering above all others will be the need to sell abroad more than ever before, with the unpleasant feeling that if we do not our economy, now grinding painfully into third gear, might easily crash back into neutral.

The publicity granted to exports will be greatly increased. Towards the end of the year the whole question of Britain's relationship to the common market will call for a decision. So far the interest taken by manufacturing concerns, especially engineering ones, has been encouraging. But how many will be ready to face—as they almost certainly must—Continental competition at home? So far the most coherent statements have come from those firms who hope to make a sizeable killing in Western Europe, as many undoubtedly will.

We deal in subsequent notes with a number of export opportunities and problems. On selling to the United States, the following anecdote may help in illustrating what to avoid. An English motor-car salesman, working on the West Coast, found to his amazement—and duly reported in a letter to *The Times*—that a famous British maker of sports cars refunded 10,000 dols. in orders for delivery in England. The factory had already accepted the orders, given chassis and serial numbers and confirmed date of delivery. The reason for contracting out was " that the factory was to go on holiday." Exporting successfully is as much an attitude of mind as a question of product design and prices. To acquire export consciousness, for without it we cannot live, is unquestionably the high task of the next twelve months.

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New York Danger Signals

Last week Mr. William McChesney Martin, chairman of the Federal Reserve Board, told a Committee of Congress that " the economic problem to-day is a high level of business activity with no shortages except in savings." In other words that inflation continues to be the primary threat to the country's prosperity.

Other voices, little more than rumblings in the distance at present, suggest that the weak points are in demand for products, not the shortage of credit or the level of interest rates. Manufacturing capacity has increased at a very high rate, far in excess of production. An article in *Business Week* of July 13, " Output Lags as Capacity Grows," is a most striking illustration of this point. For example, steel mills have worked to 87 per cent. of capacity during the first half of the year, the current rate is down to 80 per cent.; petroleum refiners' rate has fallen from 96·1 per cent. last year to 88 per cent.; manufacturers of electrical machinery (including electrical appliances) are down to 85 per cent.

The question agitating most people is the effect on industry of any reduction of government expenditure on armaments. For example, machine tool makers are expressing concern over possible effects on themselves of cuts in the military aircraft programme. Many other sections of the engineering industry are likewise apprehensive. So much so that Congress is to undertake a study of the effect of government spending on the economy.

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Rule Britannia

For a year or so British turbo-prop aircraft will dominate the " civilian air." It is clear that the first-rate performance and popularity of Vickers' Viscount airliners has paved the way for the interest now being shown in Bristol's Britannias. The news released last week that Trans-World Airlines were negotiating for the supply of 30 of these aircraft, and the reasons given for this by their controlling shareholder, Mr. Howard Hughes, suggest that until jet airliners are available the Britannias will be by far the best aircraft available for the North Atlantic routes.

The American insistence on early delivery would provide T.W.A. with something better than their competitors until Boeing 707 and Convair 880 jets become available. (T.W.A. are said to have 33 and 30 respectively on order). But it would also handicap B.O.A.C. The Corporation have 18 Britannia 312 long-range aircraft on order, and would be reluctant to release any of these to a United States competitor. They would be forced to buy more large United States piston-engined aircraft and would presumably miss the opportunity of capitalising on a British development.

An American report on the proposed deal argues that " dollar-eager Britain " would show a net gain of about 100 million dollars (nearly £36 million) on the transaction. The full value of the deal is said to be 150 million dollars (£54 million), including spares. But how much dollar income would it cost B.O.A.C.?

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A Question of Form

Described as " the first scientific study of its kind undertaken in Britain " a survey of feminine shapes and sizes has just been published, but its value to engineers is much more than might at first be supposed. In a 134-page report, entitled *Women's Measurements and Sizes**, the Clothing Industry Development Council analyse the results of research on the body measurements of some 5,200 British women, between the ages of 18 and 70. The purpose of the survey, carried out by the Council's women field workers in 1951, was to provide clothing manufacturers with reliable information for use in improving their systems in sizing women's garments.

The vital statistics contained in this report will be of value to all who design machines and equipment used by women operators—as the article beginning on page 194 shows. The average woman has been found to be 5 ft. 3 in. tall and weigh 9 st. 10 lb., but the fact that 37 different measurements were made on each of the 5,208 women in the sample—and that all the measurements made are tabulated in the report—makes it possible to assess whether a piece of equipment will be suitable for the majority of women, or only " Miss Average."

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Catering Changes

The news that the Board of Earls Court Limited have changed their catering arrangements for exhibitions and all other shows held at Earls Court will fall on unbelieving ears. That anything should be done about a state of affairs so distressing to so many is certainly a surprise. Catering at Earls Court has become synonymous with our proverbial lack of interest in food.

The new caterers are Peter Merchant Limited. The Board say that the new arrangements " should provide satisfactory high-class catering facilities for exhibitors and the public generally."

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The Other Side

British exporters will draw comfort from the findings of an American trade mission after a tour of the Union of South Africa. Their report contains very pointed criticism of the policies and practices of American exporters and compares them unfavourably with British and Continental methods.

First there is the refusal of United States manufacturers to manufacture specially for export: " markets must adapt themselves to American taste and American standards." Secondly, the universal belief that American service is unrivalled is unceremoniously shown to be a myth. In the case of goods such as machinery and vehicles, it is the European suppliers who " see to it that spare parts are available." Thirdly, American exporters appear to pass on the full domestic price increases to their South African customers.

Many of these complaints would have come the way of any investigating mission who took the trouble to talk to importers. Nonetheless it is good to see a nation other than Britain criticised for lapses in export markets. More important, perhaps, is the mission's view that South Africa " provides a great opening for private investments not only within the country itself," but also " as a catalyst for the impending industrialisation of neighbouring Africa."

* Published by H.M.S.O., price 30*s.*

ATOMIC REVIEW

Concrete Cases

CONTAINMENT of the pile within a concrete pressure vessel instead of a steel one is the most interesting feature of the French reactors G2 and G3. The reactors are the same size as those at Calder Hall, and are sited side by side as shown in Fig. 1. Their purpose is the same too—plutonium production. But three inches of welded steel is replaced by three metres of prestressed concrete.

This feature of the reactors, which are being constructed at Marcoule, was mentioned in ENGINEERING two years ago (vol. 180, page 491, 1955). Opportunity is taken now to give further details that have just been released. Fig. 2 is a flow diagram and Figs. 3 and 4 are longitudinal and transverse cross-sections of one reactor.

The G2 reactor contains about 100 tons of uranium and develops between 150 and 200 MW of heat. As will be seen from Fig. 1, the fuel-element channels are horizontal—an arrangement chosen to minimise the metallurgical difficulties in supporting the fuel. The differing neutron and temperature conditions that exist throughout the pile have made it necessary to split the flow of the carbon dioxide coolant into two zones. A circle 0·6 of the radius of the active cylinder defines the first zone; the second zone is the remaining part of the pile. A separate turbo-blower supplies each zone. The figures for the conditions existing in the two zones are given in Table I, on page 218, together with other details of the reactor.

As it is not possible to achieve a perfectly gas-tight concrete tank, a stainless-steel tank 3 cm. thick has been inserted within the concrete one. It also acts as a thermal shield. A maximum temperature of less than 100 deg. C. is expected in the concrete. The rate of prestressing has been chosen so that the concrete tank will start to crack, and allow gas to escape, before it bursts, this being the lesser of two evils.

Refuelling is possible when the reactor is on load. A moving platform at one face of the reactor carries the loading mechanism. The total weight of the device is 200 tons. The tubes visible in the drawing, that slope out from the vertical sides of the reactor, are the unloading channels. They penetrate the pile diagonally and all the slugs on one diagonal come out of one chute. When slugs fall out of the reactor they pass through a system of pipes until they enter gas-tight chambers and locks that permit their exit from the pile. On leaving the pile the elements are sealed in aluminium containers and stored.

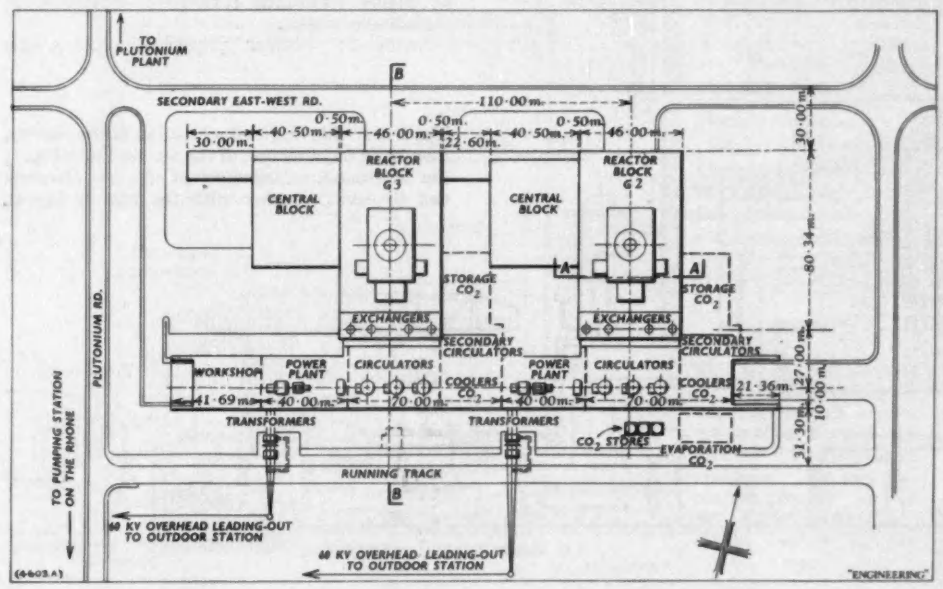


Fig. 1 The reactors G2 and G3 are sited side by side at Marcoule. The two are identical and designed primarily for plutonium production, but electricity is also generated.

Because of the type of fuel charging used, there is no graphite reflector on the rear face of the reactor. The fuel slugs themselves have 16 fins of which four are longer than the rest and serve as supports.

The control and safety rods of the reactor pass vertically through the pile. To allow the rod mechanism to be inspected regularly, a concrete structure is erected on the top of the reactor to provide the necessary shielding. The whole system is cooled by a carbon-dioxide circuit (Fig. 2). A useful length of 4·7 metres is achieved with the rods. There are 51 of them, each being hollow and containing boron-carbide. The rods have an external diameter of 40 mm. and an internal diameter of 28 mm.

General Notes

South of Scotland Station

After some six months of negotiation, permission has now been granted for construction to proceed on the 320 MW nuclear power station to be built by the G.E.C.—Simon-Carves Atomic Energy Group for the South of Scotland Electricity Board (see Atomic Review, December 21, 1956, February 8, 1957, and February 15). Mr. J. S. Maclay, Secretary of State for Scotland, made this announcement recently after examining a report of the public inquiry on the project at Largs, Ayrshire (*Nuclear Generating Station*, Stationery Office, 2*s*.). The station, which will be built at Hunterston and is likely to cost £37 million, is expected to have an output worth about £4 million per annum—roughly a quarter of the total electrical output in the South of Scotland. The G.E.C.—Simon-Carves Atomic Energy Group are associated with the Motherwell Bridge and Engineering Company, Limited, and Mowlem (Scotland) Limited.

Castings for South of Scotland Station

A.P.V.—Paramount Limited, the stainless and special alloy steelfounders of Crawley, Sussex, have received a contract for steel castings to be incorporated in the South of Scotland nuclear power station from the General Electric Company, Limited (Atomic Energy Division). The castings, of which several hundred are to be supplied, weigh approximately 800 lb. each and form the guide pans through which the control rods are lowered into the reactor core.

U.S. Power Projects

To bring up to date our record of United States nuclear power projects (Atomic Review, April 12 and May 17), attention is drawn to the proposal of the Florida Nuclear Power Group (including Florida Power Corporation, Florida Power and Light Company, and Tampa Electric Company) to develop, design and build a nuclear power plant fuelled with natural uranium. The plant, which would be gas cooled and moderated by heavy water, would generate 136 (electrical)

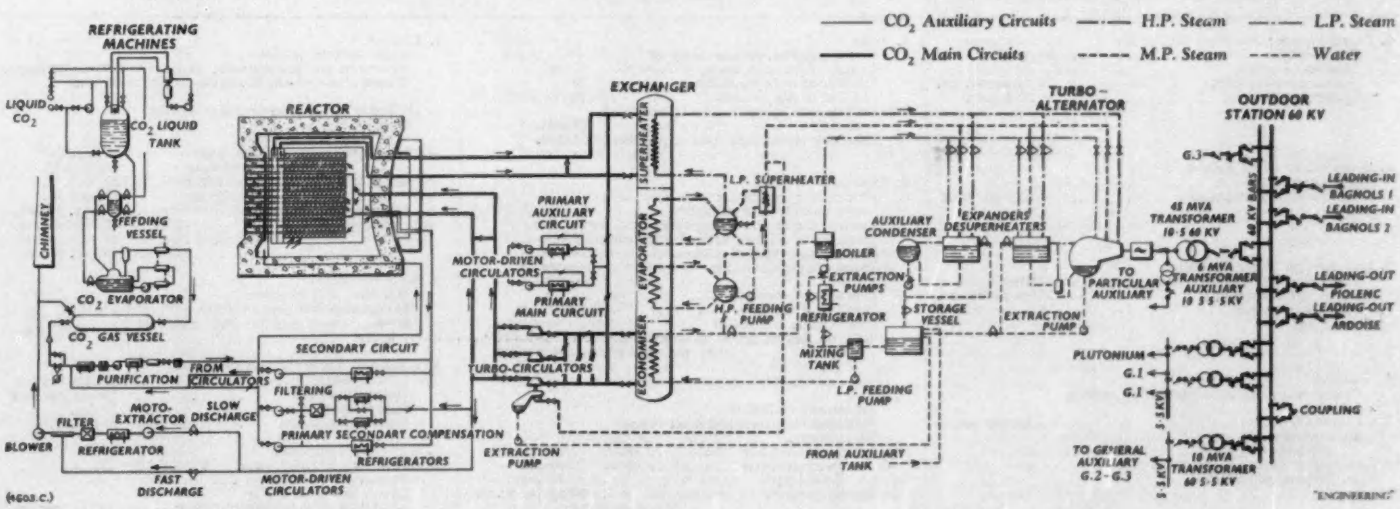


Fig. 2 The flow diagram of the system shows how the heat is extracted from the dual cooling circuit of the reactor.

MW and cost about 40 million dols. Consultants for this project (and also for the Carolinas-Virginia plant) are to be General Nuclear Engineering Corporation headed by Dr. W. H. Zinn.

U.S. Uranium Allocation

Last month President Eisenhower announced that 59,800 kg. of uranium 235, in addition to previous allocations, may be made available for peaceful uses in the United States and abroad under conditions prescribed by the United States Government. The additional quantities of uranium 235 which will be made available for distribution over a period of years are: (*a*) 30,000 kg. in the United States, through lease for all licensed civilian purposes, principally for power reactors; and (*b*) 29,800 kg. outside the United States, through sale or lease, to governments of individual nations or to groups of nations with which the United States concludes agreements for co-operation. Distribution of special nuclear material will be subject to prudent safeguards against diversion of the materials to non-peaceful purposes. Added to the 40,000 kg. of uranium 235 designated on February 22, 1956, and the 200 kg. designated earlier, this designation brings to 100,000 kg. the total amount of this material to be made available as required for peaceful purposes, divided equally between domestic and foreign uses.

Plutonium Prices

The price to be paid to United States reactor operators for plutonium by the United States Atomic Energy Commission between now and July 1, 1962, has been established at from 30 to 45 dols. per gram, depending on the plutonium 240 content. From that date until June 30, 1963, the guaranteed price will be 30 dols. per gram. It has been pointed out in *Nuclear Engineering* (July, page 270) that the credit price for plutonium quoted by Mr. J. A. Jukes (economic adviser to the U.K.A.E.A.) in his World Power Conference Paper (ENGINEERING, July 5, page 20, 1957) as a rough basis for estimating power costs is 0·06*d.* per kWh, which corresponds to £4 6*s.* 0*d.* per gram of pure metal, depending on the conversion factor. £4 6*s.* 0*d.* (11·5 dols.) is about one-third of the United States figure. If the British credit price were raised to correspond to the American 30 to 45 dols. then the cost of power from Britain's nuclear power stations would fall accordingly, probably to below 0·5*d.* per kWh, so that nuclear power would be cheaper than conventional power. This calculation would suggest that the British authorities have been very conservative in their cost estimates and that the gas-cooled reactor is likely to be even more successful than has recently been supposed. The basis of the calculation has not, however, been given, and since the Authority will probably be responsible for processing the spent fuel from at least the early reactors, the plutonium credit will in effect be paid for the plutonium content of spent fuel. Since accurate figures for fuel processing and plutonium extraction costs have not been published, and since these costs are implied by Mr. Jukes' figures, which are in any case purely illustrative, the conclusions drawn can only be taken as an indication.

Second Geneva Conference

The British Government have accepted an invitation from the Secretary-General of the United Nations to participate in a second International Conference on the Peaceful Uses of Atomic Energy, to be held in Geneva in 1958 from September 1 to September 13 inclusive. The last Conference, in 1955, occurred at a time when a great deal of work previously held classified by the United Kingdom, America and Canada was released for publication, and the same will be true of the next one since further important fields of work have recently been declassified. A provisional topical agenda has been agreed by the seven-nation advisory committee, of which Sir John Cockcroft is the United Kingdom member, providing for 12 plenary sessions embodying papers of a general survey type, and four parallel series of technical sessions (68 three-hour sessions in all). The technical sessions cover the following subjects.

Series 1: chemistry and the chemical processing of irradiated fuel; reactor technology; radiation damage in reactor materials; handling of highly irradiated materials; treatment of radioactive wastes.

Series 2: nuclear physics, including the

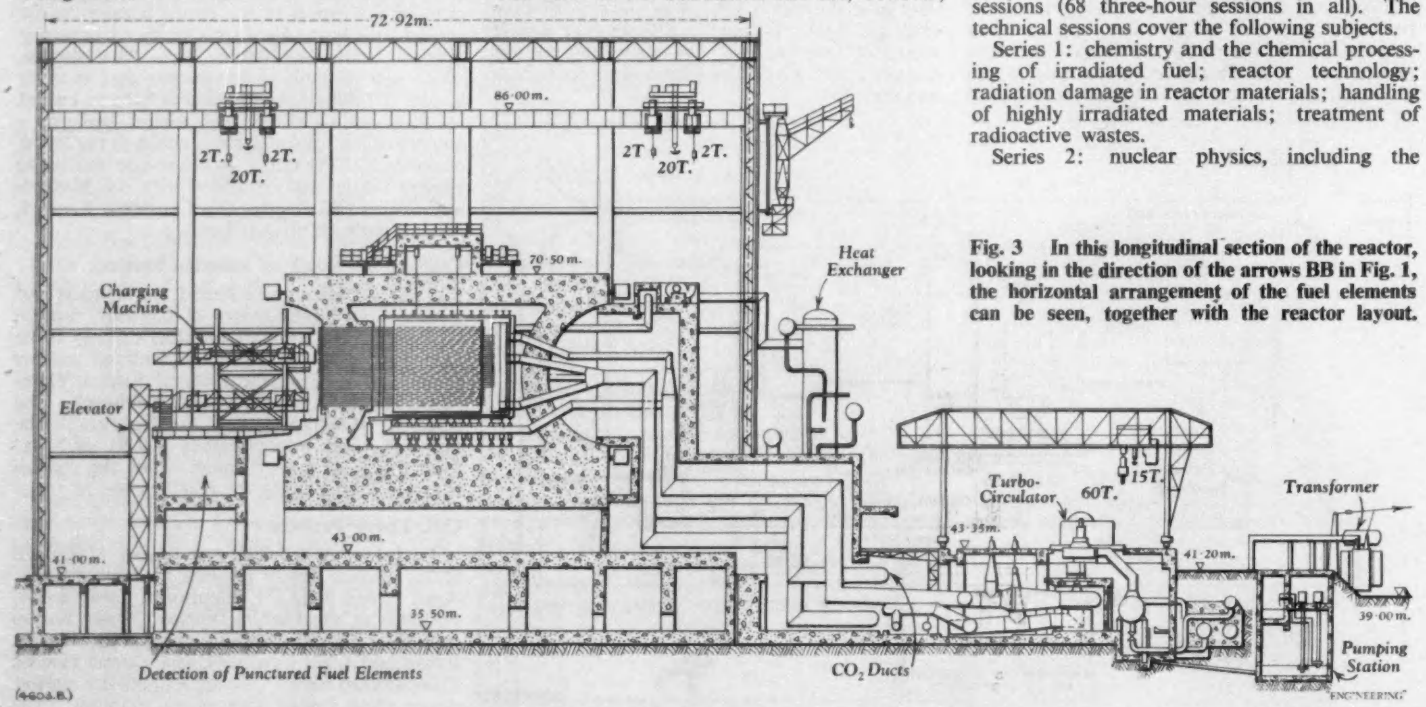


Fig. 3 In this longitudinal section of the reactor, looking in the direction of the arrows BB in Fig. 1, the horizontal arrangement of the fuel elements can be seen, together with the reactor layout.

TABLE I.—CHARACTERISTICS OF G2 AND G3 REACTORS AT MARCOULE

CO_2 Storage and Cleaning		Reactor		Reactor Cooling	
1. *Liquid Storage: For Both G2 and G3*		1. *Slugs*		1. *Coolant*	
Total capacity	90 tons	Fissile material: natural uranium		Kind: carbon dioxide	
Number of vessels	3	Length of the rods, about	30 cm.	Maximum working pressure: about	15 kg. per sq. cm.
Storage pressure (abs.)	20 kg. per sq. cm.	Number of rods per channel	28	Weight of carbon-dioxide in the circuit	80 tons
Storage temperature	− 20 deg. C.	Number of fins per rod	16	2. *Cooling of Active Core (Primary Circuit)*	
2. *Evaporation: For 1 Reactor*		Diameter of uranium rods at centre of pile	28 mm.	Number of zones: inlet	2
Number of sets	2	Diameter of uranium rods at periphery	31 mm.	outlet	2
Total evaporation capacity	2 tons per hour	2. *Moderator*		Inlet temperature: central zone	80 deg. C.
3. *Gas Storage: For 1 Reactor*		Moderator: graphite; density, 1·7; cross section, 3·9 millibarns		external zone	150 deg. C.
Total capacity	11 tons	Length of cylinder without reflector	845 cm.	Outlet temperature: central zone	305 deg. C.
Storage pressure (abs.)	22 kg. per sq. cm.	Diameter of cylinder without reflector	785 cm.	external zone	354 deg. C.
Number of vessels	6	Thickness of external reflector	100 cm.	Lift flow rate: central zone inlet	528 kg. per sec.
4. *Cleaning*		Shape of graphite laying	square	(at 200 MW) outlet	821 kg. per sec.
Continuous cleaning in parallel on cooling circuit		Pitch	20 cm.	external zone, inlet	469 kg. per sec.
Cleaned flow-rate	1 kg. per sec.	Diameter of channels	7 cm.	outlet	176 kg. per sec.
Set consisting of:		Number of channels	1,200	3. *Main Circulators*	
Filtering on paper		Disposition: horizontal		Number: 3 (1 in reserve)	
Oil-removing on activated coal		Neutron flux at centre of reactor (150 kW) $2·5\times10^{13}$ neutrons per sq. cm. per sec.		Maximumpower per circulator / Drive: steam turbine and reduction gear	2 × 3,850 kW / 1 × 2,350 kW
Drying on alumina		3. *Shield*		4. *Cooling of Shield (Secondary Circuit)*	
		Strong and biological		Inlet flow-rate	540 kg. per sec.
		Prestressed concrete and inner vessel		Outlet Flow-rate	500 kg. per sec.
		Dimensions:		Inlet temperature	25 deg. C.
		Inner diameter	1,400 cm.	Outlet temperature	50 deg. C.
		Outer diameter	2,000 cm.	5. *Secondary Circulators*	
		Total length	3,370 cm.	Number: 2 (1 in reserve) + 1 stand-by	
		Testing pressure	30 kg. per sq. cm.	Power: 2 × 670 kW + 1 × 102 kW	
				Drive: electrical motor	
				Maximum flow-rate per circulator	500 kg. per sec.

physics of fission and fusion reactors; reactor theory; fuel cycles and the economics of nuclear power; research, test and prototype power reactors; reactor experiments.

Series 3: production and uses of isotopes and ionising radiations in research, medicine, agriculture and industry; dosimetry; biological effects of radiation; radiological protection; reactor safety and location; meteorological and oceanographical aspects of the large-scale use of atomic energy.

Series 4: raw material supplies; winning and refining of uranium and thorium; methods of separation of isotopes; metallurgy and fabrication of fuel elements; processing of other nuclear materials.

The Conference will be conducted under the same rules of procedure as in 1955, which are published as Annex II in column 16 of the *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*. Officials of the Conference, namely, the president, vice-presidents, secretary-general, deputy secretary-general, chairmen and vice-chairmen of the technical sessions will be announced later.

Arrangements for United Kingdom participation are being organised through an executive committee (chairman, Sir John Cockcroft; secretary, Mr. B. W. Mott) and a papers committee (chairman, Dr. B. F. J. Schonland; secretary, Dr. T. A. Hall), on which are representatives of the United Kingdom Atomic Energy Authority, the Central Electricity Authority, industry, universities and other bodies. Titles and 500 word abstracts of papers must be in the hands of the secretary-general of the United Nations by March 1, 1958, and final texts by June 1, 1958. At present the papers committee is engaged on the compilation of a provisional list of titles, with the object of ascertaining the approximate total number likely to be submitted by the United Kingdom and the distribution between the various sessions. It is hoped that this information will be available by September 1, 1957. Organisations represented on the papers committee will be approached by their representatives for contributions, but others are invited to communicate directly with the papers secretary, at the Atomic Energy Research Establishment, Harwell, Berks, if they have titles to submit or if they seek further information. Inquires concerning matters other than the submission of papers should be addressed to the secretary of the executive committee, at the same address.

Atom 1957

An exhibition, " Atom 1957," is to be organised by the *Sunday Times*, with the full co-operation of the United Kingdom Atomic Energy Authority. To be held at Park Lane House, London, W.1, during the last three weeks of October, the exhibition will demonstrate and explain the peaceful uses of atomic energy in a simple non-technical manner, with particular reference to applications in industry, medicine, agriculture and research.

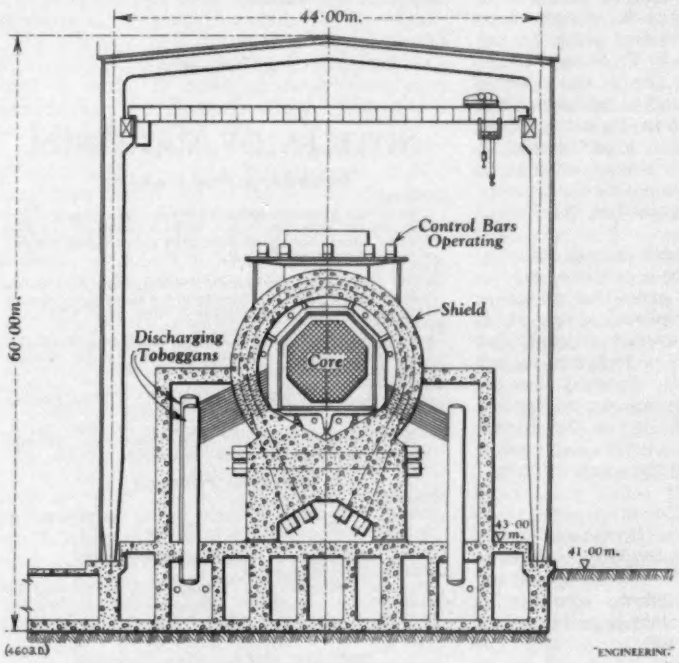


Fig. 4 The transverse cross-section, looking in the direction of arrows AA in Fig. 1, gives an idea of the prestressing problems. The fuel discharge channels at 45 deg. to the vertical face of the reactor can be seen.

Nuclear Congress

The 1958 Nuclear Congress, which is being organised by the American Institute of Chemical Engineers, 25 West 45th-street, New York 26, N.Y., and sponsored by some 30 professional, technical and scientific societies, is to take as its theme: " Industrialising the Atom." It will be held in Chicago, Illinois, and will include the following functions: Fourth Nuclear Engineering and Science Conference (March 17 to 21); Sixth Atomic Energy in Industry Conference (March 17 to 19); Fourth International Atomic Exposition (March 16 to 21); Sixth Hot Laboratories and Equipment Conference (March 19 to 20); and American Power Conference (March 17 to 19). The Congress is being co-ordinated by the Engineers Joint Council, 29 West 39th-street, New York 18, N.Y., to whom all inquiries should be addressed.

Atom Week

The United States Atomic Industrial Forum, 3 East 54th-street, New York 22, N.Y., and the American Nuclear Society, P.O. Box 963, Oak Ridge, Tennessee, are holding an International Atom Week in New York, on October 27, 1957. The proceedings will include a trade fair and conferences on various aspects of nuclear energy and its applications. Information may be obtained from the Atomic Industrial Forum.

Nuclear Standards

An attempt has been made in Geneva to unify the standard practice of countries which are developing the peaceful uses of nuclear power. Specialists from some 30 countries have recently attended the first meeting of a new committee on nuclear energy of the International Organisation for Standardisation. The committee's object is to recommend standard practices which should be followed, throughout the world, in the interests of safe and efficient operation of, and improved trade in, nuclear plant and equipment. The British delegation of nine was led by Mr. H. A. R. Binney, Director of the British Standards Institution, and included representatives from the United Kingdom Atomic Energy Authority, including Mr. F. R. Farmer, recently appointed Chief Safety Officer of the Authority's Safety Branch, the Central Electricity Authority and three of the industrial groups of the Nuclear Energy Trade Association's Conference. The conference was expected to set up three working groups to be charged with drafting recommendations on (1) terminology and symbols—a " basic language " of nuclear science; (2) reactor safety —those performance features which will contribute to safety of operation; and (3) personal safety—of workers not only at nuclear power plants but those engaged on such activities as industrial radiography.

Code of Regulations on Ionising Radiations

Mr. Iain Macleod, Minister of Labour and National Service, stated recently in reply to a Parliamentary Question that he had published the preliminary draft of a new code of regula-

TABLE I.—CHARACTERISTICS OF G3 AND G2 REACTORS AT MARCOULE—(*Continued*)

Steam Production

1. *Exchangers*
   Number: 4 in parallel
   Each set includes:
   An economiser
   An evaporator M.P.
   A superheater M.P.
   An evaporator H.P.
   A superheater H.P.
   Steam conditions at exit of the exchangers for 4 sets in parallel:

H.P. steam:	pressure	10·7 kg. per sq. cm.
	flow-rate	47·76 kg. per sec.
	temp.	334 deg. C.
M.P. steam:	pressure	2·4 kg. per sq. cm.
	flow-rate	19·05 kg. per sec.
	temp.	171 deg. C.

2. *Boiler*

Water:	inlet flow-rate	48·6 kg. per sec.
	outlet flow-rate	45·4 kg. per sec.
	inlet temp.	115·5 deg. C.
	outlet temp.	81 deg. C.
Steam:	flow-rate	3·2 kg. per. sec.
	pressure	0·5 kg. per sq. cm.

3. *Distribution of Generated Steam*

H.P. to turbo-alternator	47·76 kg. per sec.
M.P. to turbo-alternator	6·59 kg. per sec.
M.P. to turbo-circulators	12·46 kg. per sec.
L.P. to turbo-alternator	3·2 kg. per sec.

Turbine

1. *Turbine*
   Power on shaft 40 MW
   3 admissions

Data on steam:	H.P.	M.P.	L.P.
Pressure, kg. per sq. cm. abs	10·5	2·2	0·5
Flow rate, kg. per sec.	47·76	6·59	3·2
Temperature, deg. C.	334	171	81

2. *Condenser*
   Steam flow rate to condenser 57·55 kg. per sec.
   Vacuum obtained: by air pump
   Vacuum at the condenser 0·035 kg. per sq. cm.
   Flow rate of circulating water 15,500 cub. m. per hr.

3. *Auxiliary Condenser*
   Steam flow rate to condenser 57·55 kg. per sec.
   Vacuum obtained: by air pump
   Vacuum at the condenser 0·500 kg. per sq. cm.
   Flow rate of circulating water 6,590 cub. m. per hr.

Note.—The condenser is equipped with expander-desuperheater, allowing steam to be condensed in case of stopping of the group without changing the working rate of the reactor. In case of long stopping of the group, steam may be condensed in the auxiliary condenser, after being expanded and desuperheated.

Alternator and Power Dispatch

1. *Alternator*

Nominal power	45 MVA
Terminal voltage	10·5 kV
Frequency	50 c.p.s.
Speed	3,000 r.p.m.

2. *Group Transformer*

Nominal power	45 MVA
Primary:	
Nominal voltage	10·5 kV
Coupling	Δ
Secondary:	
Nominal voltage	62 kV
Coupling	star

3. *Auxiliary Transformer*

Nominal power	6 MVA
Primary:	
Nominal voltage	10·5 kVA
Coupling	Δ
Secondary:	
Nominal voltage	5·5 kVA
Coupling	star

4. *Power Dispatch*
   Out-door transformer station, 60 kV built north of the site Marcoule.
   This station, including a double set of bars, is common to reactors G2 and G3. It is connected with the general EDF mains by means of four 60 kV lines.

tions, *Factories* (*Ionising Radiations*) *Special Regulations* (*Preliminary Draft of Regulations*), obtainable from H.M. Stationery Office (price 9*d.* net, 11*d.* post free). The regulations are designed to safeguard workers employed in industry against the effect of ionising radiations. The object of publishing the regulations in draft form is to give organisations and others concerned an opportunity to consider them and to raise any points they may have with the Ministry. After these have been considered a further draft will be prepared and laid before Parliament. Representations should reach the Ministry by October 31, 1957, and should be addressed to the Secretary, Ministry of Labour and National Service, 19, St. James's Square, London, S.W.1.

Isotopes Course for Executives

The Isotope School at Harwell is arranging a three-day course from September 25 to 27, 1957, for directors and senior executives from industry to enable them to hear about and discuss the limitless uses to which radioisotopes can be put. The course will include visits to the Harwell reactors and to the Wantage Radiation Laboratories where research is progressing in the use of large radioactive sources for the irradiation of foodstuffs, pharmaceuticals and other manufactured articles. There will be talks on safety precautions to be taken when using radioactive material, on some aspects of turning an ordinary laboratory into an " active " laboratory and on the economics involved therein. Lectures will give sufficient background information to enable non-technical executives to appreciate the possibilities of the use of radioisotopes. The emphasis throughout the course will be on the practical uses of isotopes and irradiation sources in industry. A wide range of the most up-to-date equipment used in the handling of isotopes will be demonstrated and its uses explained. Those taking part will be encouraged to discuss with experts any particular applications that might be successfully and economically used in their own businesses. Accommodation can be arranged for the nights of September 24, 25 and 26, at Worcester College, Oxford, and transport to and from Harwell will be provided. The fee for the course will be £30 inclusive of all accommodation, transport, and meals. Applications will be accepted in chronological order and limited in number, and should be made as soon as possible. Forms of application and further information about the course are available from: the Registrar, Isotope School, Atomic Energy Research Establishment, Harwell, Berks.

Literature Guide

The booklet published by the U.S.A.E.C. to which reference was made in Atomic Review on August 2 (page 158) has as its title, *Guide to Atomic Energy Literature for the Civilian Application Program* (TID–4575). The guide may be obtained without charge from the Commission's Technical Information Service Extension, P.O. Box 1001, Oak Ridge, Tennessee.

National Institute for Nuclear Research

Speaking in the House of Commons just prior to the adjournment for the summer recess, Mr. Harold Macmillan, the Prime Minister, said that the first task of the National Institute for Research in Nuclear Science, which was set up earlier this year, had been to examine proposals for the construction of a new particle accelerator to permit further development of nuclear research. The design of this machine, a 7 GeV (7×10^9 eV) proton synchrotron, had now been agreed to and work on its construction put in hand. The machine, he told Surgeon Lieut.-Commander R. F. B. Bennett (Conservative) was expected to cost about £7 million, and would be built on a site to be made available by the United Kingdom Atomic Energy Authority adjacent to the Research Establishment at Harwell.

Fermi Patent Settlement

Settlement has recently been announced in the High Court of Justice between Philips Electrical Limited and the United Kingdom Atomic Energy Authority of the action arising out of the late Professor Enrico Fermi's nuclear energy patent (United Kingdom Patent 465,045). This patent is based on an invention made by Professor Fermi and his team of collaborators working in Rome in 1934, who discovered that neutrons which have been slowed down by collisions with light atoms are more effective than fast neutrons in the process of producing radioactive elements. The basic Italian patent was applied for in that year. Full title and all rights to the invention for most countries other than the United States of America were subsequently acquired by the Philips organisation, and the registered owners of the United Kingdom patent are Philips Electrical Limited.

Since 1948 there have been discussions between the patentees and the Atomic Energy Research Establishment in which Philips urged that the position concerning the patent should be clarified, but as these discussions did not lead to any agreement, the patentees caused a writ to be served on the United Kingdom Atomic Energy Authority in March, 1956, alleging infringement of the patent. In April, 1956, the patentees also presented to the High Court of Justice a petition for extension of term of the patent.

However, as the parties felt that it was preferable to settle these matters in an amicable manner, it has been possible to arrive at a compromise. The Authority have been conscious of the great contribution made to the advance of nuclear science by Professor Fermi's remarkable discovery, and also of the valuable development work in the nuclear field which has been carried out by Philips in conjunction with the Atomic Energy Research Establishment at Harwell; while Philips have been anxious to avoid causing any interference with the development of nuclear energy projects in the United Kingdom.

The terms of the settlement include the withdrawal of the petition for extension, and an undertaking by Philips to secure that no claims will be made for the infringement of any corresponding patents abroad owned or controlled by any associated company of Philips in respect of articles and materials exported by the Authority or any of the companies engaged in association with the Authority in the nuclear power programme. In return for these concessions the Authority are paying a sum to Philips.

Radiation Proof Windows

Windows capable of withstanding certain levels of radiation are being developed by Pilkington Brothers, Limited, 29 St. James's-street, London, S.W.1. The windows comprise in effect transparent tanks containing an oil such as Shell Ondima 17, a white oil.

Ceramic Heat Exchangers

A heat exchanger has been proposed which consists of a mass of sintered ceramic substance, preferably alumina, beryllia or silicon carbide, with two groups of passages running through it. Both groups consist of layers of mutually parallel passages, layers of the first group alternating with those of the second, but the passages of the two groups are arranged at right angles to each other with separate headers connecting the ends. One of the two fluids to be brought into heat-exchange relationship is then passed through the passages running in one direction while the other fluid passes through the transverse passages. (British Patent No. 766,668. N. Davey and W. J. Kramers, U.K.A.E.A.)

Appointments

Sir Christopher Hinton, managing director of the Industrial Group of the United Kingdom Atomic Energy Authority, has been appointed to the newly created post of chairman of the Central Electricity Generating Board. A major item of the board's task will be to carry through the nuclear power programme. He relinquishes his post with the U.K.A.E.A.

Mr. J. F. Herbert has been appointed to the newly created post of manager, overseas atomic projects, with the English Electric Company, Limited. He has also been elected a director of the English Electric Export and Trading Company.

Award

The first prize in the W. E. Highfield Shield Competition 1957–58, organised by the Association of Supervising Electrical Engineers has been won by Mr. D. H. Taylor, A.M.I.E.E., for his paper, " Nuclear Power Developments." Certain illustrations used in the paper were reproduced from ENGINEERING.

Cosmic Particle

What is said to be the most energetic particle observed by man has been reported by Dr. Edward Ney of the University of Minnesota. The particle, a helium nucleus detected in cosmic rays at a height of 22 miles, left a track on a photographic plate. The cosmic-ray study in which this discovery was made is sponsored by the University of Minnesota and the University of Bristol (U.K.).

Antidote for Radiation

Experiments in France have shown that resins can afford some protection against radiation Rats treated with a resin showed a higher degree of resistance to absorption of strontium 90 than those not treated.

* * *

NOTICES OF MEETINGS

Incorporated Plant Engineers

LONDON
" Maximum Demand and the Power Factor, and Their Effect on the Electricity Tariff," by T. A. Williams. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Sept. 3, 7 p.m.*

CHESTER
" The Cost Accountant and the Plant Engineer," by R. G. Hall and B. J. Willson. Mersey and North Wales Branch. The Blossoms, City-road, Chester. Mon., Sept. 9, 7.15 p.m.

DUNDEE
Discussion on " Variable Speed Drives with Voltage Regulation Equipment." Dundee Branch. Mather's Hotel, Dundee. Mon., Sept. 9, 7.30 p.m.

EDINBURGH
Open Meeting. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Sept. 3, 7 p.m.

LEICESTER
" The Painting of Buildings," by R. Woodwards. Leicester Branch. Bell Hotel, Leicester. Wed., Sept. 4, 7 p.m.

Institute of Petroleum

LONDON
" Some Developments in Marine Drilling Foundations," by A. Kranendonk. Wed., Sept. 4, 5.30 p.m.*

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Chairman's Address, by J. Teasdale; and an informal discussion on " Branch Affairs." North-East Branch. Northern Architectural Association's Hall, 6 Higham-place, Newcastle-upon-Tyne. Mon., Sept. 9, 7.15 p.m.

Institution of Production Engineers

COVENTRY
" Changing from Batch to Flow Production," by H. C. Blackford. Coventry Graduate Section. At works of the British Piston Ring Co., Ltd., Holbrook-lane, Coventry. Wed., Sept. 4, 7.15 p.m.

Royal Aeronautical Society

LONDON
45th Wilbur Wright Memorial Lecture on " Advanced Education and Academic Research in Aeronautics," by Dr. Clark B. Millikan (of the Guggenheim Aeronautical Laboratory, California Institute of Technology). Institution of Civil Engineers, Great George-street, S.W.1. Fri., Sept. 13, 6 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it understood that tea is available prior to the time stated.

Incorporated Plant Engineers, 12 The Parade, Solihull Warwickshire. (Solihull 1111).
Institute of Petroleum, Manson House, 26 Portland-place, London W.1. (LANgham 2250.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)

KARIBA AND RHODESIA'S POWER NEEDS

The blowing of the north bank coffer-dam completes the first stage of the Federal Power Board's hydro-electric project in the Kariba Gorge on the Zambesi River. The water is now diverted through the openings in the base of the dam already constructed in the northern channel and through the southern diversion tunnel and work is proceeding with the construction of the circular coffer-dam on the south bank. This is a substantial achievement for the contractors, who have made up the loss of time caused by the flooding in the spring, and for the Power Board itself which so organised the contracts, as to get the work off to a flying start. Just over two years ago the first contract was placed with Cementation Limited, for the preliminary exploratory and river diversion works, and contracts were also placed for the provision of housing and site access roads.

Up to that time nothing had been done on this wild site except the construction of an access road by the Irrigation Department and some trial borings. Other contracts followed later, including those for an access road on the north bank, a suspension footbridge and a road bridge over the river at the dam site, and the construction of the European and African townships and the railheads at Lion's Den and Kafue. The main contract was placed with the Italian contractors, Impresit Limited, in September, 1956. To-day the townships house 1,200 Europeans and nearly 10,000 Africans, including families, and 137 miles of roads have been constructed, 50 of them mainly with metal surfaces within the site area.

In order to meet the peak requirements for concrete while the dam is being poured, 80 silos have been constructed on the north bank, each with a capacity of 300 tons of cement in bulk, and storage provided for a further 3,000 tons in bags. In addition, 10,000 tons will be held at Chilanga Cement Works, near Lusaka, which is supplying practically all the cement used. The peak rate of consumption is expected to be 16,000 tons a month. Stone—2,000,000 tons of it—is being obtained from a quarry a short distance from the mixing plant and crushing machinery, conveyors and silos have been erected on the hillside on the north bank for handling this. It is intended to use up to 8 in. aggregate in the main dam structure. About 1,000,000 tons of sand are being obtained from the Sanyate River at the point of its confluence with the Zambesi and are being stored on the south bank. The total amount of concrete to be poured is in excess of 1,000,000 cub. yd.

It is expected that the river will be closed by October, 1958, and water should start to be impounded in the reservoir thereafter while the construction of the main dam continues. This will entail the plugging of the temporary openings (which have been left in the portion of the main dam already constructed on the north side) by dropping concrete bulkhead gates into prepared grooves to cut off the flow of water, so allowing permanent plugs to be constructed in the dry. The largest of these bulkhead gates will be 45 ft. high, 15 ft. wide and 6 ft. thick, and will weigh about 135 tons. The reservoir is expected to be full by 1964, but floods or droughts could advance or retard this date by as much as two years.

In view of the urgent need for the power from this project, and in order to start earning revenue from the supply of current, the design provides for low-level water inlets for the first two turbines, so that these can be operated at low head to produce about 160 MW by 1960. The first stage of the full scheme will provide 500 MW and the final stages are estimated to provide, on a conservative basis, 1,200 MW in all.

This scheme has been made necessary by the rapid increase in the demand for power in the industrial centres of the Federation of Rhodesia and Nyasaland, and particularly in the Copper Belt, where an enormous expansion of output has been taking place. In 1956, installed capacity in the Federation amounted to a total of 631·5 MW thermal and 38·1 MW hydraulic and the demand for power has been rising at the rate of 13 per cent. per year. Of this capacity, 192·8 MW were supplied by the Rhodesia-Congo Border Power Corporation and 36·3 by the Broken Hill Mine, mostly to the copper mines. The Rhodesia-Congo Border Power Corporation obtains 30 MW from the waste heat from the smelters, and 70 to 75 MW from a thermal power station at Nchanga Mine, but these sources are insufficient and are being supplemented by supplies from the Belgian Congo.

It is estimated that Kariba, which was based on an increase of demand of 9 per cent. per annum, will satisfy requirements until 1972. Further projects under consideration include one on the Kafue River, which could provide 450 MW, at the first stage, rising to 1,200 MW when completed; and, for the more distant future, on the Shire in Nyasaland, capable of producing 460 MW, and on the Zambesi at Livingstone, 250 MW.

To some extent the second stage at Kariba depends on whether Kafue is chosen for the next project. If so, more turbo-alternators could be installed at Kariba, capable of operating economically at a lower load factor, because Kafue, being more a run of the river project, would carry the base load. The load factor on which the economics of Kariba have been based is 70 per cent.

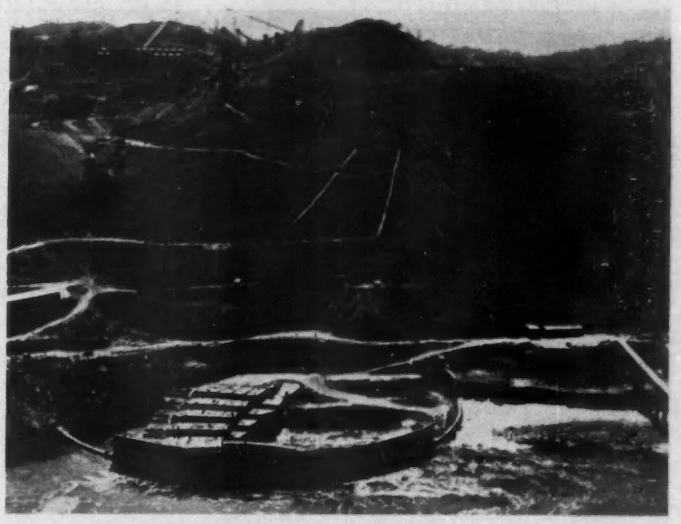
The future requirements of power in the Federation will depend not only on the expansion of the copper industry but on the growth of secondary industries in the three territories. These are, at present, proceeding slowly and it would seem unlikely that, for instance, the Shire Valley Scheme would be required for many years unless the Melanje bauxite deposits are developed. On the other hand, should demand ever exceed the potential of all these schemes, there is a further potential 3,600 MW on the Zambesi, above Tet in Portuguese East Africa.

The Kariba project is a truly international one. Of the funds for its construction, 35 per cent. have come from the International Bank, 25 per cent. from the copper companies, 23 per cent. from the Colonial Development Corporation and the Commonwealth Development Finance Company, and 17 per cent. from within the Federation itself. The main consulting civil engineers are the specially created Anglo-French firm of Gibb, Coyne, Sogei (Kariba) (Pvt.) Limited, which consists of Sir Alexander Gibb and Partners, of Westminster, A. Coyne and J. Belier, of Paris, and Société Générale d'Exploitations Industrielles, of Paris. The consulting electrical and mechanical engineers are Merz and McLellan, London. The main contractors, Impresit Limited, are a consortium of four Italian firms.

Much of the road work has been undertaken by John Laing and Son (Rhodesia), and housing by Richard Costain (Southern Rhodesia) Limited. The 140,000 h.p. water turbines are being provided by Boving and Company, Limited, London, and the 100 MW turbo-generators by Metropolitan-Vickers Electrical Export Company, Limited. The generator transformers are being supplied by the English Electric Company, and the substation transformers by Ferranti Limited. The contractors for the main switchgear are British Thomson-Houston Export Company, Limited, and the power lines are being supplied by Rhodesian Power Lines (Pvt.) Limited.

Most of the contractors' plant is American, although a large number of British trucks are in use, including more than 600 Land Rovers.

The chairman and chief executive of the Federal Power Board is Mr. D. L. Anderson, C.B.E., T.D., M.I.C.E., M.I.Struct.E., to whom a great deal of the credit is due for the speed with which this project has gone forward. Mr. Anderson was previously research manager for the Colonial Development Corporation in Africa, and before that in the Caribbean.



Progress at the Kariba Dam. The north bank coffer-dam was blown on July 6 last. The river will now be sealed off on the south side and the remainder of the dam foundation constructed " in the dry." The dam will then be built up to its full height while the river passes through the openings between the foundation blocks and the southern diversion tunnel. Pre-cast concrete bulkheads will then be used to plug the openings which will afterwards be filled with concrete.

Obituary

MR. H. H. JOHNSON

Former Editor of "Engineering"

ENGINEERING has lost one of the few remaining links with Dr. W. H. Maw, who edited this journal from 1866 to 1924, and the present Directors and staff a valued friend and colleague, by the death on August 3 of Herbert Henry Johnson, for many years a member of the Board and formerly a joint Editor. Mr. Johnson, who was 82 years of age, had been in poor health for some months, but it was only a few weeks ago that his condition began to deteriorate so seriously that he was obliged to discontinue his occasional visits to the office in which so much of his working life had been spent.

Mr. Johnson was a native of Bootle, Lancashire, where he was born on July 19, 1875. On leaving the Merchant Taylors' School at Great Crosby, Liverpool, he was apprenticed to the marine engineering firm of Arrowsmith, Sinclair and Company, Liverpool, with whom he served for five years in the fitting, turning and erecting shops. On completing his apprenticeship he entered what was then University College, Liverpool, now Liverpool University, where he took a three years' engineering course from 1895 to 1898 and, in his third year, was successful in securing a Whitworth Exhibition.

His first engineering employment after obtaining his diploma from the College was in Nottingham, where he spent two years as erector and draughtsman with Poyser, Heywood and Acland, textile engineers. His next post was with Ferranti, Limited, at Hollinwood, where he was leading draughtsman in the switchgear department for three years. He was then, for a short time, chief draughtsman with Lionel Robinson and Company, Limited, at Thames Ditton, but in 1904 he returned to Manchester to spend the next five years in the engineering department of the British Westinghouse Electrical and Manufacturing Company, subsequently to become the Metropolitan-Vickers Electrical Company.

It will be seen, therefore, that he had already acquired a varied and useful experience in both mechanical and electrical engineering when in May, 1909, he joined the editorial staff of ENGINEERING. The journal was then under the joint editorship of W. H. Maw and B. Alfred Raworth; but by this time Maw was 70 years old—albeit a remarkably vigorous 70—and, moreover, had many outside claims upon his attention, so that it was largely to Raworth, of whom he always spoke with a most affectionate regard, that Johnson owed his training in technical journalism. For the next six and a half years, to the end of 1915, his duties were the normal ones of any assistant editor—and, it may be remarked, there is no better method of learning the extent and variety of the engineering industry. Naturally an observant man, he made the most of his opportunities and, in the professional institutions which he joined and the works that he had occasion to visit, made also many contacts which developed into lifelong friendships.

By the close of 1915 the first World War was already becoming a struggle between engineering capacities as much as between massed armies in the field, and the new munitions factories were requiring as many trained engineers as they could get. In December of that year, therefore, Johnson left ENGINEERING on what, no doubt, he supposed would be only a temporary assignment, to take up the position of night manager in the National Projectile Factory at Lancaster, an establishment which eventually expanded until it employed over 10,000 workpeople. He remained there for four years, becoming in succession manager of the 60-pdr. shell shops (which turned out about a million and a half shells) and, finally, assistant superintendent of the whole factory. In the latter capacity he was responsible, under the superintendent, for the production of aircraft bombs and much other war material as well as shells. He returned to ENGINEERING in March, 1919, with a considerably enhanced experience in management as well as production, which proved a valuable asset.

He continued to serve ENGINEERING as an assistant editor until December, 1924, when he was appointed joint Editor with Major (later Lieut.-Colonel) P. J. Cowan, M.B.E. Shortly after Cowan's retirement in February, 1939, Johnson decided to retire also, though he remained for a few months longer while the new joint Editors, Mr. Charles Cooper and Mr. J. Foster Petree, took over their duties. Then the second World War broke out, the editorial and publishing offices had to be transferred temporarily to Hayes, Middlesex, and, as the hostilities spread, the production of a weekly journal began to present problems for which even the first World War had provided no precedent. So one morning, with no previous notice, Mr. Johnson reappeared and, observing merely that "Before long you people are going to need all the help you can get," forthwith appointed himself once more an assistant editor, and continued as such until the return of more normal circumstances enabled him to retire again. This time it was in earnest, or as nearly as he ever came to that conception, for he remained a member of the Board until his death and continued to contribute occasionally to our columns. Nor would anyone have had it otherwise, for as a Director his counsel was always shrewd and to the point, and his opinions—which usually had to be sought, and which were delivered with a truly remarkable economy of words—accurately reflected his keenly observant and analytical mind.

After his retirement, when he went to live in Harpenden, he was seen comparatively seldom at the meetings of the Institutions of Mechanical and Electrical Engineers, to both of which he had belonged for many years, but he continued to attend occasionally those of the Royal Institution, of which also he had long been a member, and thus was enabled to keep in touch with his numerous scientific friends. He joined the Whitworth Society at its inception and took a very active interest in its affairs, which was recognised by his election as President of the Society in 1950. In 1926, when *The Whitworth Book*, containing the names and brief biographies of all the recipients of Whitworth awards to that date, appeared under the honorary editorship of the late Professor D. A. Low, Johnson contributed to it an excellent memoir of Sir Joseph Whitworth; and only last year he collaborated with Dr. F. T. Barwell, the present honorary secretary of the Society, in compiling and editing *The Whitworth Register*, the new publication which brought up to date the records in the earlier volume, now long out of print. Enhanced printing costs necessitated, in the revision, a considerable compression of the material in the previous work, but it is a matter for satisfaction that his memoir of Whitworth was retained, with but slight modification. For many years he took part in the expanding work of Aslib and thereby kept in touch with librarians and information officers.

Frequently as the task has to be faced in technical journalism, it is always difficult to write adequately as well as quickly a valedictory survey of the life and labours of some long-familiar professional figure, however distinctive and clear-cut the main features of his career. It is doubly difficult in the case of a colleague of many years, who has devoted the greater part of his working life to being one of a team; for the production of a technical journal such as this is essentially teamwork, and the individual who may control the team at any given time is still no less an integral member of it. In "H. H.," the consciousness of that basic fact seemed to grow stronger with the passage of time, and it is to us a reason for gratitude, as it was to him a source of contentment, that he was able almost to the last to take his part as one of the "Elder Brethren" of the journal to which he had devoted so many years.

A Colleague Writes:

There are occasions when a technical journal is being prepared for press when events move smoothly to their climax with the precision of a well-designed machine. There are others when chaos seems imminent and both wits and tempers are strained to win the race between time and the printers. Both in calm and stress "H. H.," as he was known in the office, exhibited an imperturbability which was communicated with good results to those with whom he worked. This level-headedness is not the least of the qualities desirable in an editor.

During periods of less stress "H. H." also exhibited qualities that may be commended. He was a stickler both for accuracy and clarity. He was himself a writer of high standard, as he showed in the numerous leading articles which he prepared for ENGINEERING articles which were frequently distinguished by informed criticism as well as by humour and irony, as far as these can be exercised in a technical journal. In this regard his wide background knowledge of many branches of engineering stood him in good stead and was placed fully at the disposal of his juniors on the staff. Above all he possessed that elusive quality of charm which made him appreciated throughout a wide circle of engineering friends and acquaintances.

"H. H.'s" interests were not, however, confined to technical matters. He was a close student of literature, especially of history, about which he could talk informatively. He appreciated music, and until his last days a good deal of his time was spent in the garden. He delighted in foreign travel in which he indulged annually. As a colleague and a friend he will be greatly missed.

He leaves a son, Professor D. C. Johnson, who after being educated at Mill Hill and Cambridge was a student-apprentice with Rolls-Royce Limited. He later returned to Cambridge as a lecturer, where he was also engaged in research; he is now professor of mechanical engineering at Leeds University.

He also leaves a daughter, Miss N. H. Johnson, B.Sc., who occupies a senior position in the water pollution branch of the Department of Scientific and Industrial Research.

His wife, who died some years ago, was the sister of Sir Charles Webster, the historian.

* * *

This year's £100 prize given by members of the industrial art committee of the Federation of British Industries, to enable a final-year student of the Royal College of Art to travel abroad before commencing an industrial career, has been awarded to Mr. Maurice Evans, Walsall. He was educated at Queen Mary's Grammar School, Walsall, and at Birmingham College of Art. At the Royal College of Art, London, he studied in the department of industrial design (engineering).

In Parliament

A MATTER OF COMMERCIAL JUDGMENT

The concluding sitting of the House of Commons, prior to the summer recess, was enlivened by a number of adjournment debates; three of these being concerned, respectively, with oil-marketing interests in Israel, overseas investment in Britain's motor-car industry, and the fate of the Royal Ordnance Factories.

Interesting points were raised in the first-mentioned of these debates regarding Government responsibility concerning firms in which they possess a majority shareholding and the duties of Government-nominated directors. Mr. John Dugdale (Labour), who opened the debate, complained that the announcement by the Shell Oil Company of Palestine that it would discontinue its operations in Israel had come as a shock. He believed that the decision was due to Arab pressure, such as had been exercised against firms of many different nationalities working in Israel.

The company was owned fifty-fifty by the Shell Petroleum Company Limited, and the British Petroleum Company Limited, and the Government owned 56 per cent. of the shares in the latter. The Government, therefore, had a definite responsibility. They should intervene and instruct the Palestine company to remain in Israel, and to continue to take oil to that country and to refine and market it there.

Mr. J. Langford-Holt (Conservative) said that he did not wish to imply that he agreed wholly with what had been said by Mr. Dugdale. In his view, the matter was a commercial one with strong political implications. It was also a supreme example of fecklessness on the part of the companies concerned.

GOVERNMENT-NOMINATED DIRECTORS

The Government, Mr. Langford-Holt said, had consistently said that the directors representing them on the board of British Petroleum took no part in the commercial activities of the firm. If that were so, it was difficult to know what the directors did do. Perhaps they watched the political implications of the company's activities and, in those circumstances, he wondered whether they fully complied with the provisions of the Companies Act, 1948. In his view, directors should watch the commercial affairs of the company they directed and, otherwise, be withdrawn from the board.

Mr. Reginald Maudling, the Paymaster-General, pointed out that the Shell and British Petroleum companies collaborated in Israel in two ventures, each run by a separate subsidiary company, though both were under the joint Shell-B.P. umbrella: a refining company and a marketing company. The refinery firm was managed by British Petroleum and the marketing firm by Shell. The marketing firm was concerned solely with marketing. It owned petrol pumps, depots, and ancillary equipment, and employed about 500 people, mostly Israelis.

British Petroleum and Shell had decided, as a matter of commercial judgment, that the continued operation of the marketing company was no longer commercially justifiable, and they had decided to try to dispose of the marketing company as a going concern. It was inconceivable that they would just abandon the firm's installations and employees, if they did not find a purchaser by the end of the year. He did not believe there was any danger of a breakdown in the supply of petroleum products to Israel. By reason of their majority shareholding in British Petroleum, the Government appointed two *ex-officio* directors. These persons played a very normal part as directors and also discharged certain special responsibilities which had often been explained. No Government to date had interfered in the commercial decisions of British Petroleum and there was no reason why the present Government should interfere in what was a commercial matter. The decision about the marketing company was taken in the normal course of business by the firms concerned. It was not a political decision and no one would gain if it were represented as such.

INVESTMENT IN THE MOTOR INDUSTRY

In reply to the debate on overseas investment in Britain's motor industry, Mr. Nigel Birch, the Economic Secretary to the Treasury, told Mr. Maurice Edelman (Labour), who opened the subject, that the Government's object in permitting foreign investment was to increase Britain's reserves and to facilitate the liberalisation of trade. All cases of foreign investment came under the Exchange Control Act and there were three main criteria which the Government applied in considering them, at least one of which had to be satisfied. They were: would the particular investment increase Britain's exports; would it decrease Britain's imports; and would it bring to this country any worthwhile technical experience? The Massey-Harris-Ferguson deal would not only bring money into the country but would also increase Britain's exports considerably. The company had volunteered the information that it was 90 per cent. Canadian controlled.

RAIN-MAKING EXPERIMENTS

Mr. James Johnson (Labour) referred the Secretary of State for the Colonies to certain rain-making experiments being conducted in East Africa and asked whether he was aware that these endeavours were causing inconvenience to other farmers. Mr. John Profumo, the Colonial Under-Secretary of State, replied that some farms in the West Kilimanjaro area were suffering from drought. At the request of the local farmers' association, an officer of the East African Meteorological Department had attended a meeting and explained the principles and mechanics of seeding rain clouds with small balloons which are designed to explode and scatter salt into potential rain clouds in order to induce precipitation.

Some members of the association tried out this balloon method in the early part of this year on their own account and were successful in inducing an appreciable increase in the rainfall on their farms. It was understood, however, that owing to inexperience, the wrong clouds were seeded in one or two instances, with the result that rain fell on the land of a neighbouring farmer at a time when his harvesting operations required fine weather.

ANGLO-AMERICAN TRADE

A comparison between the effects on Anglo-American trade of restrictions imposed by the United States and the United Kingdom, respectively, was sought by Mr. W. M. F. Vane (Conservative). On these matters, Sir David Eccles, the President of the Board of Trade, stated that imports into the United States from the United Kingdom were almost wholly free from quantitative restrictions. During the last two years, the United States Government had increased the customs duties on two products of interest to the United Kingdom—bicycles and linen towelling—but reductions had been made in other United States tariffs to compensate for these increases. The United States Government had also introduced a tariff-quota system for wool fabrics, and the interests of this country might be affected by the new limitations on imports of oil.

Apart from minor adjustments in the sizes of some quotas, no additional import restrictions had been placed on imports into the United Kingdom from the United States in the last two years and, as far as was known, no tariff increase by this country had materially affected the interests of the United States. None the less, import restrictions and prohibitions continued to apply, for balance of payments reasons, to a very wide range of United States imports and it would, Sir David considered, be misleading to attempt to compare the actions of the two countries.

IMPROVING SOUTH WALES PORTS

The Minister of Transport and Civil Aviation was pressed by Mr. H. R. Gower (Conservative), the Member for Barry, to make a statement regarding the Government's efforts to increase the use of dock facilities at the Bristol Channel ports. Mr. Harold Watkinson pointed out in his reply that it was for traders to choose, in co-operation with the shipowners, what ports they would use, and that it was not for him to influence them in favour of particular towns. The British Transport Commission and local interests, however, were doing what they could to encourage the greater use of the South Wales Bristol Channel ports.

The Commission had carried out a number of improvements to these ports and others were in progress. In May last, new works in hand and plant and equipment on order were valued at nearly £3·5 million. These improvements included the electrification of the Commercial Graving Dock pumping station and the Queen Alexandra Dock No. 1 power station, Cardiff, and the provision of a new bulk-cargo-discharging berth at Barry.

SHIPPING AND RAIL CHARGES

Possibilities of altering the present apportionment of dock charges between shipowners and shippers at South Wales ports, Mr. Watkinson emphasised, had been thoroughly examined by experts of the Industrial Association of Wales and Monmouthshire, the British Liner Committee, and the British Transport Commission. At a meeting of the interests concerned, arranged by the Ministry of Transport in March last, the British Liner Committee had undertaken to inform the shipping lines of the Association's views. The Committee had made it clear, however, that they could not commit the shipping lines to any particular course of action and that the Association themselves would have to pursue the matter direct with the shipping conferences and lines involved.

As to the level of railway rates at the ports, another point which was raised by Mr. Gower, a new procedure had come into force with the Rail Charges Scheme on July 1. This procedure, Mr. Watkinson stated, would give the British Transport Commission greater freedom in fixing railway rates and the chairman of the Commission had said that it was their intention that no port, or group of ports, should be given an advantage over others.

Safety Regulations in Shipbuilding

Answering a question by Mr. Frederick Willey (Labour), regarding the revision of the safety regulations in the shipbuilding and ship-repairing industries, Mr. Iain Macleod, the Minister of Labour and National Service, stated that a preliminary draft of the new regulations issued under the Factories Acts in respect of shipbuilding and ship-repairing work in wet docks and harbours, as well as in shipbuilding yards and dry docks, had now been published. Extensive comments on these regulations had been received from the trade unions, employers' federations and other interested organisations. These comments had been carefully studied and were being discussed with the organisations concerned. The task was a substantial one, involving the consideration of a mass of detail, but progress would be made as rapidly as possible.

Equal Pay for Equal Work

Information was requested by Mr. Fenner Brockway (Labour) concerning the manner in which the United Kingdom delegate to the Economic and Social Council of the United Nations voted on certain resolutions at a meeting on July 24 last. He was told by Commander Allan Noble, the Minister of State for Foreign Affairs, that the delegate abstained from voting on resolutions approving full political rights for women and on equal pay for equal work.

THE HUMAN ELEMENT

Redundancy Without a Sting

Addressing the London Extension Summer School last week, Mr. L. Langdon Goodman made the useful point that it is jobs and not men who become redundant and that redundancy of jobs is essential in a progressive economic society. It is all to the good when some of the emotion can be discharged from a catch-word, and such a word " redundancy " has long been considered. Words of this sort become fashionable to clothe certain ideas evoked by fear in the industrial community. " Unemployment " is another one.

Words can become fashionable and they can also fall out of fashion. The falling out, however, may need some other jingle of words to bring it about. In these matters we are more primitive than we are perhaps prepared to admit. We adjust ourselves to new circumstances—in this case it is probably automation—not by accepting the logic of events but by adopting new slogans to kill off old ones—a device which has long been the stock-in-trade of the politician and the propagandist. If the separation of the job from the man (and it is a genuine differentiation in an age of full employment) aids in the acceptance of the need for men to change their occupations more rapidly as technical change becomes increasingly rapid, so much the better. The need for a catch phrase on these lines may become increasingly imperative in the next few years if the Free Trade Area joins up with technical change to speed up still further the expansion and contraction of certain industries.

Working in Compressed Air

A draft regulation has been published by the Minister of Labour and National Service requiring special measures to be taken to protect the health and safety of men employed on work in compressed air. This draft enables those concerned with its provisions to raise any points they may wish with the Ministry before the regulation is finally prepared and put into operation.

The dangers arising from incorrectly controlled decompression after working in a compressed-air environment have been known for a long time. The proneness of divers to " the bends " is the best known example of what may occur. The new regulation deals with supervision of compressed-air operations, the construction and maintenance of bulkheads, size and equipment of man-locks, the use of man-locks including attendants, working conditions in them and egress from them, and medical supervision. Provision is also made for the compulsory provision of hot drinks for those just removed from a man-lock and for the prevention of the consumption of alcohol on such occasions. A register must also be maintained called the Compressed Air Register in which men subject to such conditions must have an outline medical history recorded. Copies of *Work in Compressed Air, Special Regulations*, 1957, can be obtained from H.M.S.O., price 8*d*.

Benefits for a Rainy Day

In the year ended December, 1956, the Ministry of Pensions paid out £870 million. Of this, more than half was in retirement pensions. There were a number of important changes during the year. Among the most important were increased pensions for war orphans, allowances for the children of war widows and a higher maximum rent allowance for such widows. A new age limit was introduced for family allowances and there were higher allowances for larger families. Other changes included higher earnings limits for retirement pensions and widows' benefits, and the payment of a weekly supplement to people still entitled to workmen's compensation.

As might have been expected there were more people receiving unemployment insurance benefit in December, 1956, than at the same time a year before. The number was nearly 168,000 compared with 121,000 at the same time in 1955. Unemployment benefit cost about £15½ million last year. The number of claims for injury benefit was slightly lower on the year at 822,000. The number of national insurance contributors at March 31, 1956, was over 24 million, of whom more than 16 million were men.

Engineers for India

Under the heading " India turns out 3,000 engineers a year," *India News* publishes an analysis of the country's needs and some details of the education and training projects which are provided for in the second Five-Year Plan. An outlay of some Rs. 530 million, about 2½ times the expenditure on technical education under the first Plan, has been authorised.

An engineering personnel committee appointed last year to inquire into the requirements of trained engineers for the implementation of the second Five-Year Plan have criticised these provisions as inadequate. They recommend that more colleges should be established and that the capacity of the existing institutions should be increased. A scheme has therefore been formulated for an annual intake of 8,680 into the degree course, and 18,735 into diploma courses in and after 1960-61.

These are ambitious targets, though not perhaps impossible to realise since the annual intake into institutions granting degrees in engineering is currently 5,000 and into technical colleges granting diplomas about 8,000. Perhaps the most striking achievement of the first Five-Year Plan was the establishment of the Indian Institute of Technology at Kharagpur, which started functioning in 1951 and now has a student population of 1,400 undergoing courses and doing advanced work in 15 departments. Three more institutions of this kind are to be set up. A factor which appears to have been fully appreciated by Indians is that modern industry requires a good supply of well-trained technical men. It is the lack of such men as well as the lack of funds which is holding back progress.

Fruitless Task

The rejection by the Covent Garden strikers of terms negotiated on their behalf by the London secretary of the Transport and General Workers' Union is a slap in the face of the kind Mr. Cousins enjoys when not at the receiving end. Officials of the T.G.W.U. are now desperately busy trying to stop the strike spreading further. Already, last week, support was forthcoming from 1,000 cold-storage workers and 2,000 dockers. The strikers were seeking further support at a meeting held last week-end in Trafalgar Square. The secretary of the strike committee made it quite plain that " after four weeks of struggle and sacrifice, the workers are more than ever determined to get justice."

The T.G.W.U. officials indignantly rejected the strikers' statement that their representative had been " 100 per cent. tricked by the tenants in the market." This is, they said, either deliberate misrepresentation or complete misunderstanding.

There would appear to be a great deal of misunderstanding. Mr. Cousins' huge union serves many trades, each with a tradition and special characteristics. Increasingly he is finding it difficult to find a common denominator in the interests of T.G.W.U. members. The Covent Garden men have their own problems, not the least of which is their fear that the privileges will be taken out of their employment by the employers' insistence on the unification of labour. Their acceptance of joint control of recruitment and of an " efficiency committee " to report on means of creating the " maximum possible efficiency " is some way towards accepting the need for a change on technical grounds. The human aspects of the problem, however, currently dominate and cloud the whole issue.

Welcome to Canada

Canada's need for engineers is great and urgent. Opportunities for the well-trained man abound and every facility is given him to settle down quickly and easily. This is the message sent out to the technical Press in this country by the Iron Ore Company of Canada, and supported by two booklets. One of these, entitled *Welcome*, is described as an " employee induction booklet." It gives an outline of the company's main activities—the Quebec-Labrador iron-ore project and the Quebec North Shore and Labrador Railway—and detailed information on conditions of employment, training facilities, housing, health, hospital treatment and insurance schemes and pensions.

The other booklet, called *There's a Future in Iron Ore*, describes what the company and their associates do for a living and indicates under the heading of each main department the type of jobs which are available. The company's salary policy is described as " aggressive " and salaries are " equal or higher than those paid for similar work elsewhere in Canada."

This kind of publicity is good and will appeal. It goes much further than any British recruitment campaign known to us. Canada is unlikely for long to be short of engineers if leading companies follow the policy of I.O.C.C.

Danse Macabre

A letter in a recent issue of the *Daily Telegraph* claimed that the sight of porters folk-dancing late at night on Number 2 platform at Basingstoke (as the writer had witnessed it) would not have occurred prior to nationalisation. Such remarks, whether written seriously or in jest, point to a prevalent illusion, namely, that the substitution of one large form of organisation for another even larger has such a benign effect on the individuals concerned that they generate some kind of a care-free cultural renaissance among themselves.

This is a dangerous mixture of fantasy and ignorance. Does anyone really think that the nationalisation of the coal industry had any great effect on the virile miners' choirs on the North East Coast or on the brass-band tradition of the South Yorkshire coalfield? These were there and thriving long before the printing presses got round to turning out draft Bills for nationalisation. They arose and continue to flourish out of a sense of community, of belonging—not out of an organisation chart. It is true that a change of organisation or of ownership may bring a change in efficiency—but it does not make unskilled workers blow harder on their euphoniums or dance with joy.

No doubt Basingstoke is ready to lead the world—indeed, as W. S. Gilbert assures us, it is a word that teems with hidden meaning—but almost certainly the porters' nocturnal caper was but a momentary aberration. If the modernisation programme now in hand on British Railways makes all the massed array of porters at Euston Station Morris Dance at midnight it will prove no more than that capital investment has made some labour redundant on the railways and that the trade unions have successfully resisted any attempt to use that labour elsewhere.

ENGINEERING

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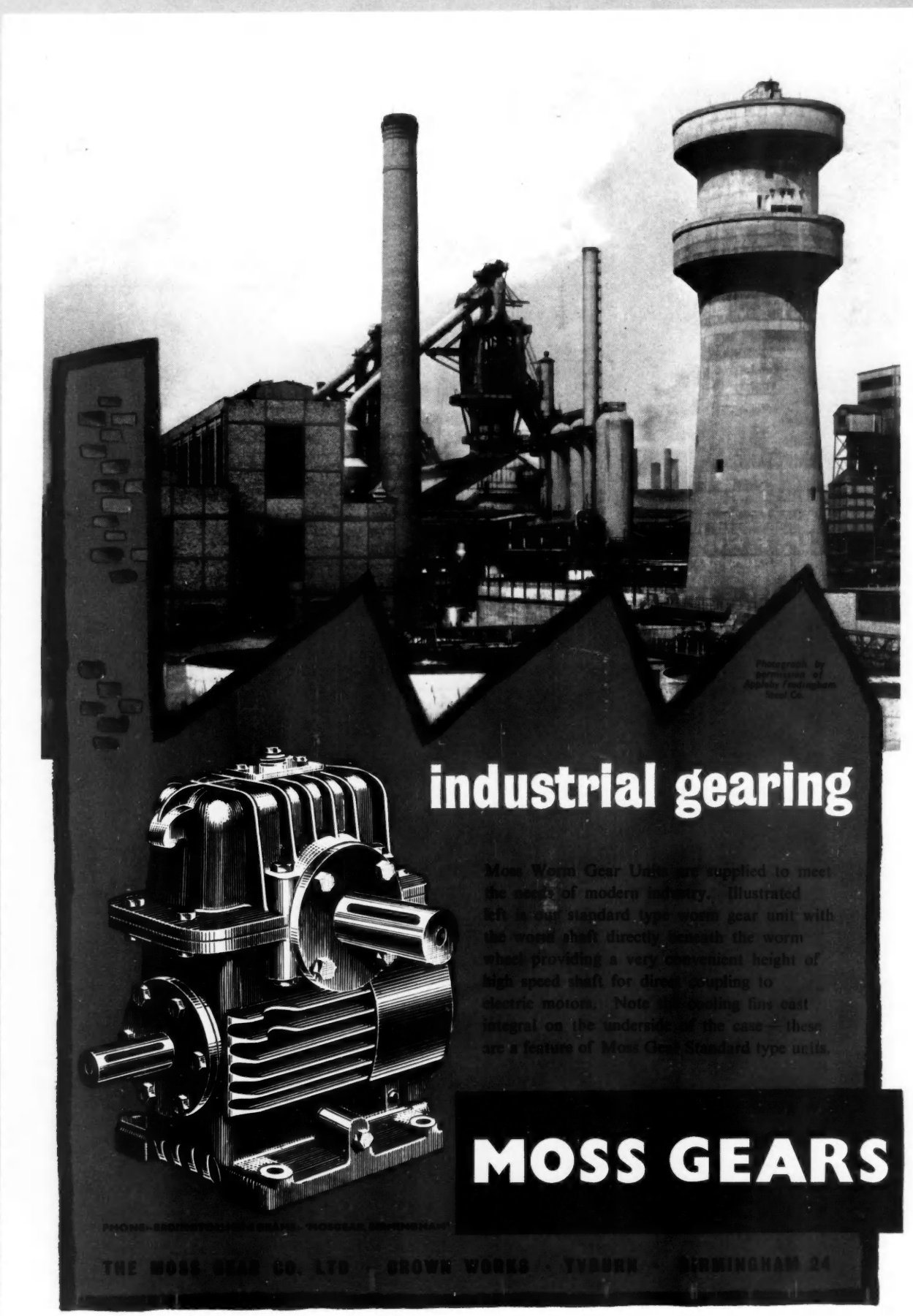
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